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Final Technical Report
August 1988

OPERATION OF RELIABILITY ANALYSIS CENTER (FY85-87)

IIT Research Institute

Kevin L. Lindquist

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ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

This report presents the updating efforts and the description of research and development (R&D) efforts undertaken in support of DoD agencies in the area of Reliability and Maintainability. Information is provided concerning the operating costs, technical publications developed, user services provided and income derived for the period 1 October 1984 through 30 September 1987.

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PREFACE

The Reliability Analysis Center (RAC), technically managed by Rome Air Development Center (RADC), is a Department of Defense Information Analysis Center with the express purpose of serving as a focal point for the recovery of reliability test and experience data on electronic systems and the components used therein. It is one of several DoD Information Analysis Centers, administratively managed by the Defense Logistics Agency (DLA), operating in unique, narrowly defined technical areas. Since its inception in 1968, the RAC has been operated by IIT Research Institute under contract to the U.S. Air Force first at its Chicago Headquarters and since 1972 at RADC, Griffiss Air Force Base, New York. The RAC mission is to collect, analyze, synthesize, format and disseminate reliability information on electronic equipments/systems and on the microcircuit, discrete semiconductor and electromechanical components that make up the functional hardware. Analyzed and evaluated reliability information is disseminated through reliability compilations, handbooks, appropriate special publications and direct consulting assistance to support defense systems development and to upgrade their reliability. The RAC engineering services are made available, under service charge arrangements, directly to government agencies and contractors, enabling efficient application and utilization of the accumulated knowledge and information to specific problems.

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1.0 INTRODUCTION

This is the Final Report for Operation of the Reliability Analysis Center, in accordance with CLIN 0002, Item A0007, DI-S-3591A/T, under Contract F30602-84-C-0162. Information concerning expended effort, accrued operating cost, volumes produced, user services (and income derived from these services), and distribution of technical publications is provided for the period 1 October 1984 to 30 September 1987.

2.0 SUMMARY OF TECHNICAL ACCOMPLISHEMENTS

2.1 Significant Accomplishments

During this contract period twelve RAC Newsleters, more than 13,000 Information Packages and numerous Training Course Brochures were mailed to RAC customers.

The Reliability Analysis Center produced sixteen new output products during this contract. These products provide information on Mechnical Reliability, Microcircuit Device Reliability, IC Quality Grades, Surface Mount Technology, Electrostatic Discharge (ESD), and Nonelectronic Parts Reliability. Also, included are Search and Retrieval Indexes to IRPS and ISTFA Proceedings.

During the contract period more than 5,000 RAC products were distributed and several publications were reprinted to meet order demands.

RAC personnel attended 21 meetings/conferences in support of the contract. The Reliability Analysis Center presented a paper on the "Reliability and Maintainability of Electronic Systems Exposed to Long Term Dormancy" for the Norwegian Defense Research Establishment (NDRE), Lillestrom, Norway. The RAC was invited by the NATO Advisory Group for Aerospace Research and Development (AGARD) to present this paper.

The Design Reliability, Practical Statistical Analysis, Electronic Equipment Testability and the Worst Case Analysis Training Courses were presented for a combined total of 51 times. The Design Reliability Training Course was presented for the 100th time. The Electronic Equipment Testability and Worst Case Analysis Training Courses were presented for the first time.

The Reliability Analysis Center's (RAC) engineering staff was involved in 41 Special Projects for DoD and Non-DoD government agencies during the performance of this contract.

IIT Research Institute provided a Hewlett Packard (HP) 9000 computer to support the RAC Information Processing needs.

A new MIS system was implemented which tracks every customer transaction in detail. Some of the advantages of this new system are improved accuracy and productivity in the orders processing department.

2.2 Problems Encountered

No significant problems were encounted.

3.0 USER NEEDS

The RAC Newsletter was published twelve times during the contract, with a distribution of nearly 20,000 for each issue.

More than 13,000 Information Packages were mailed during the contract. In addition, user awareness letters describing new RAC products and services were distributed at various times throughout the contract (see Attachment 1).

Throughout the contract, brochures were mailed on the Design Reliability, Statistical Process Control, Testability Practices Today and the Worst Case Analysis Training Courses (examples are contained in Attachment 2).

3.1 User Services

Technical and Bibliographic Inquiries and Services: There were 627 technical and 132 bibliographic inquiries received during the contract. A sample listing of organizations served can be found in Appendix A-1.

3.2 Products Produced

Sixteen new publications were produced, published and marketed:

Analysis Techniques in Mechanical Reliability, (NPS-1), September 1985

This publication contains an extensive discussion of the current design analysis techniques used for assessing the reliability of mechanical parts, systems and materials. Today's technological, sociological, and economic considerations dictate that devices be designed to optimize cost, size, weight and reliability. However, these parameters impose conflicting demands on the designer of a mechanical device. Quantitative estimates of cost, size and weight can be readily established. NPS-1 provides techniques for determining quantitative estimates of reliability of mechanical devices. Meaningful trade-off studies can then be implemented to determine the effect on performance, cost, size and weight of various designs. The text includes techniques such as stress-strength interference theory and other probabilistic design methods.

Microcircuit Device Reliability, Trend Analysis Databook, (MDR-21), July 1985

MDR-21 is devoted to the investigation of possible trends developing in microcircuit reliability. This publication evaluates patterns evolving in the industry, identifying trends which are appearing as integrated circuits incorporate new designs with increased capabilities and decreased dimensions.

This report addresses digital devices of small, medium and large-scale integration, linear, interface and memory components, and very-large-scale integrated circuits. MDR-21 is separated into sections based on these functional distinctions and is further subdivided by factors believed to influence operational performance. These factors include: basic technology (Bipolar or MOS); screen class; application environment; device packaging; materials and construction; part complexity; power dissipation; operating temperature.

Microcircuit Device Reliability, Field Experience Databook, (MDR-21A), August 1985

MDR-21A is the first publication produced by the Reliability Analysis Center to deal exclusively with field reliability experience of microelectronic components. Digital SSI, MSI, LSI, Linear, Memory, Interface and VLSI devices are included. When used in conjunction with MDR-21, Microcircuit Device Reliability Trend Analysis, this document provides valuable information in the selection of microcircuit components.

Volume I contains data on all types of microcircuits (excluding hybrids) and is divided into three primary environmental sections: Airborne, Ground and Naval. Each section is subdivided by component functional type, specific application environment and device functions.

Volume II, the Failure Event/Analysis portion, contains detailed listings of the failure's causes which were analyzed following a unit failure. This analysis contains information regarding the device characteristics and environmental conditions at the time of the reported failure as well as the exact nature of the failure.

The diskette format (FMDR-21A) contains information from MDR-21A on three diskettes. The diskette format allows users with IBM or IBM-compatible personal computers to utilize a supplied step-by-step query program designed to allow non-programmers to extract specific data records. The data bases are also accessible through the Ashton-Tate dBase III software package to allow the user to produce custom reports.

IC Quality Grades: Impact on System Reliability and Life Cycle Costs, (SOAR-3)

The purpose of this 100-page state-of-the-art report is to present the main factors governing the relative reliability and suitability of plastic commercial (screened and unscreened), hermetic commercial, and JAN-qualified integrated circuits (ICs). Specific areas addressed include:

- Comparison of initial cost and procurement lead time.
- Discussion of various application stresses of particular concern with plastic commercial ICs.
- Procurement practices for obtaining the best available plastic ICs.
- Life Cycle Cost Analysis for the alternative part quality grades.

Confidence Bounds for System Reliability, (SOAR-4)

This state-of-the-art publication supplies algorithms for estimating confidence bounds on system reliability from subsystem reliability estimates only. Four theoretical methods providing total system reliability bounds from sub-system test data are numerically compared through a simulation study. They are compared with respect to a number of statistical criteria and the most suitable procedure developed into a step-by-step guide for engineers.

State-of-the-Art Report "Surface Mount Technology: A Reliability Review" (SOAR-5)

This publication discusses the reliability of surface mounting technology (SMT) in the context of today's manufacturing environment. The document investigates SMT's impact on the manufacturing/user community both in terms of resources, cost and performance.

The report reviews specific failure mechanisms of surface mount packages, solder joint connections and printed wiring boards. Evaluating each of these provides the basis for failure rate predicting models, a highlight of the publication. While most of the material presented is applicable to different device types and package styles, the emphasis is on surface mount packaging and reliability. SOAR-5 presents a dynamic evaluation of a potentially vital technology.

ESD Control in the Manufacturing Environment (SOAR-6)

This document supersedes SOAR-1 (ESD Protective Material and Equipment: A Critical Review). SOAR-6 addresses the establishment of an adequate, cost-effective ESD-control program for the manufacturing environment. An "ideal" ESD control program is developed to provide adequate protection for critical, high-intrinsic-value electronic parts and equipments. This program can be tailored to address specific environments and products based on susceptibility, manufacturing environment, and intrinsic value of the product. SOAR-6 defines specific product qualification and acceptance tests for various ESD protective materials and an effective ESD control program monitoring plan.

Proceedings of the EOS/ESD Symposium 1984, (EOS-6)

The newest volume contains papers presented at the 1984 annual EOS/ESD Symposium by speakers from government, industry and universities, addressing a wide variety of EOS/ESD-generated problems along with measures currently being employed to overcome them. The RAC serves as a primary source of the Proceedings which are published by the ESD Association.

Proceedings of the EOS/ESD Symposium 1985 (EOS-7)

The newest volume contains papers presented at the 1985 annual EOS/ESD Symposium by speakers from government, industry and universities, addressing a wide variety of EOS/ESD-generated problems along with measures currently being employed to overcome them.

Search and Retrieval Index IRPS Proceedings 1979 - 1984, (TRS-2A)

This publication provides a multi-year cross-reference index to the content of papers published in the proceedings of the International Reliability Physics Symposium (IRPS) covering the period 1979 through 1984. The referenced papers cover all facets of electronic device technologies, testing, screening, environments, uses and applications. The papers portray the most vital, complex, innovative and up-to-date work being done in the ongoing effort put forth by the electronics community to understand and overcome electronic device failure mechanisms.

Search and Retrieval Index to EOS/ESD Symposium Proceedings 1979 -1984, (TRS-4)

This index provides a quick search mechanism for accessing available information on failure mechanisms, failure causes, and technology influences related to electrical overstress/electro-static discharge. The papers in the Proceedings provide recommendations for circumventing or mitigating potential EOS/ESD problems and also provide references to evaluation and qualification testing. Increased information retrieval capability given by this index avoids duplication of previous studies.

Search and Retrieval Index to ISTFA Proceedings 1978-1985 (TRS-5)

This publication simplifies information retrieval from the International Symposium for Testing and Failure Analysis (ISTFA) Proceedings. Information is included on every article printed in the eight-year span of ISTFA Proceedings, and may be selected via abstract, alphabetical listing of index terms, author, date presented, papers, corporation, keywords in title, and subject.

Nonelectronic Parts Reliability Data, 1985 (NPRD-3 Hard Copy and FNPRD-3 Diskette Copy)

This publication, available in two formats, is a major reference for failure rate and failure mode information on a variety of mechanical, electromechanical, electrical, pneumatic, hydraulic, and rotating parts. NPRD-3 contains additional part types not found in previous editions, additional applications of field operating environments, better component failure mode identification, and increased industrial and commercial quality component field data.

Equipment field experience data from military, commercial and industrial sources were reviewed for completeness and examined for inherent biases; field failure rates prescribed in the generic and detailed sections were derived from only verified failure data. Included are component MTBF's for devices which have experienced at least one field failure. Failure rate information covers many devices for which no MIL-HDBK-217 reliability prediction models exist.

The diskette format (FNPRD-3) allows the data to be used in custom sort routines, to write custom queries and to produce custom reports. The three disks include a step-by-step query program.

Nonoperating Reliability Databook (NONOP-1)

This publication is the first RAC databook devoted entirely to one specific field use condition. NONOP-1 is a compilation of nonoperating field and test data for an assortment of electrical and electro-mechanical parts. The data presented have been collected by the Reliability Analysis Center (RAC) from many government and nongovernment sources.

NONOP-1 provides summarized and unsummarized data on a variety of part types. Records are grouped to allow quick comparisons between related part types. Summary data tables provide field failure rates for the merged data records along with their respective predicted failure rate values. Predicted failure rates have been derived using RAC's Nonoperating Reliability Prediction System (RAC-NPRS) which is based on RADC Technical Report, Impact of Nonoperating Periods on Equipment Reliability, RADC-TR-85-91. A component failure rate section for miscellaneous components which are not currently represented by reliability prediction models and a section outlining the effects of periodically testing nonoperating systems are also presented. This book is intended to complement documents such as RADC-TR-85-91 or MIL-HDBK-217.

Nonoperating Reliability Prediction System (RAC-NPRS)

This comprehensive software system predicts the impact of nonoperating periods on equipment reliability. The results of this analysis is useful when the target system is subjected to extensive storage periods and relatively short operating times. In this situation, the majority of the failures will often occur during the nonoperating period, regardless of the fact that the operating failure rate is generally much higher. It is intended that this analysis will complement a prediction of operating reliability. All models used in the prediction are based on research described in RADC-TR-85-91, "Impact of Nonoperating Periods on Equipment Reliability."

Electronic Equipment Reliability Data (EERD-2), 1986

This publication provides life cycle reliability data on military electronic equipment at the set, group and unit levels. The data in this document are taken from an equipment-level data base containing both contractual and technical requirements for system reliability, availability and maintainability. The contractual description consists of the goals and criteria set forth by the procuring agency, specifically citing the appropriate military standards and revisions for reliability prediction and demonstrations. The technical description consists of the design approaches, technologies, major operating parameters and complexity specific to each equipment.

EERD-2's purpose is to evaluate common reliability practices and to investigate the relationships between those parameters designed to assist in the development of reliable equipments. Statistical and graphical analyses were performed on the data to determine the relative

effectiveness of current reliability indicators. The results of these analyses are presented in an unbiased evaluation which (1) examines each reliability parameter for its independent effectiveness and (2) determines which parameters predominately enhance the capabilities of reliability forecasting.

EERD-2 contains extensive field data which was not available for its predecessor, EERD-1.

3.3 Product Sales

Figure 3.3-1 shows RAC product name, code, and quantity distributed for the 3-year contract period.

3.4 Publications Reprinted

Additional quantities of the following RAC publications were reprinted to meet order demands.

Publications	Title	No. Reprinted FY'85	No. Reprinted FY'86	No. Reprinted FY'87	Total Sales To Date
MDR-14	Hybrid Circuit Data - 1980		200		652
MDR-19	Digital SSI/MSI Data - 1984		100		667
RDH-376	Reliability Design Handbook - 1976	507	714	700	9,617
SOAR-1	ESD Protective Material and Equipment: A Crtical Review		300		1,809
SOAR-3	IC Quality Grades: Impact on System Peliability and Life Cycle Costs		200		687
TRS-2A	Search; Retrieval IRPS Proceedings 1979-1984		100		258
TRS-3A	EOS/ESD Technology Abstracts 1982		200		780
VZAP-1	ESD Susceptibility 1983	300			307
EOS-4	1982 EOS/ESD Symposium Proceedings	322			168

Code	Product Name	Quantity Distributed FY'85	FY'86	FY'87	Total
DSR-3	Transistor/Diode Data Data 1980	50	9	8	67
MDR-14	Hybrid Circuit Data 1980	56	7	7	70
MDR-15	Digital Evaluation & Generic Failure	52	13	9	74
MDR-16	Linear/Interface Data 1981	0	1	0	1
MDR-18	Memory/Digital LSI Data 1982	77	24	17	118
MDR-19	Digital SSI/MSI Data 1984	181	36	11	228
MDR-20	Linear/Interface Data 1984	88	68	13	169
MDR-21	Reliability Trend Analysis 1985	0	88	23	111
MDR-21A	Field Experience Data 1985	53	28	30	111
MDR-21S	MDR-21 and MDR-21A Data Set	0	58	0	58
MDR-SET	MDR-14, 15, 18, 19, 20 & DSR-3 Data Set	0	13	0	13
NPRD-1	Nonelectronic Parts Reliability 1978	0	2	0	2
NPRD-2	Nonelectronic Parts Reliability 1981	223	36	0	259
NPRD-3	Nonelectronic Parts Reliability 1985	0	457	259	716
VZAP-1	ESD Susceptibility 1983	148	90	69	307
EEMD-1	Electronic Equipment Maintainability	27	11	11	49
EERD-1	Electronic Equipment Reliability 1980	56	20	0	76
EERD-2	Electronic Equipment Reliability 1986	0	114	79	193
FMDR-21A	Field Experience Data 1985	0	3	9	12
MFAT-1	Microelectronics Failure Analysis	137	170	57	364
NPS-1	Analysis Techniques for Mechanical Rel.	0	460	82	542
RDH-376	Reliability Design Handbook 1976	914	342	380	1,636
SOAR-1	ESD Protective Materials & Equipment	126	37	0	163
SOAR-2	Practical Statistical Analysis	398	142	79	619
SOAR-3	IC Quality Grades	380	153	25	558
SOAR-4	Confidence Bounds for System Reliability	0	136	25	161
SOAR-5	Surface Mount Technology	0	180	277	457
SOAR-6	ESD Control in the Mfr. Environment	0	35	443	478

FIGURE 3.3-1:
PRODUCTS DISTRIBUTED FY'86 AND FY'87

Code	Product Name	Quantity Distributed FY'85	FY'86	FY'87	Total
EOS-1	1979 EOS/ESD Symposium Proceedings	85	16	37	138
EOS-2	1980 EOS/ESD Symposium Proceedings	91	14	35	140
EOS-3	1981 EOS/ESD Symposium Proceedings	98	20	38	156
EOS-4	1982 EOS/ESD Symposium Proceedings	107	21	40	168
EOS-5	1983 EOS/ESD Symposium Proceedings	133	27	47	207
EOS-6	1984 EOS/ESD Symposium Proceedings	245	94	50	389
EOS-7	1985 EOS/ESD Symposium Proceedings	0	149	63	212
EOS-8	1986 EOS/ESD Symposium Proceedings	0	30	139	169
EOS-SET	EOS-1, 2, 3, 4 and 5 Set	0	36	0	36
TRS-1	Microcircuit Screening Effectiveness	42	23	8	73
TRS-2	Search and Retrieval IRPS	92	24	25	141
TRS-2A	Search and Retrieval IRPS	114	34	40	188
TRS-3A	EOS/ESD Technology Abstracts	54	20	10	84
TRS-4	Search & Retrieval Index EOS/ESD	71	24	13	108
TRS-5	Index to ISTFA Proceedings	0	27	91	118
	TOTAL	**4,098**	**3,292**	**2,549**	**9,939**

FIGURE 3.3-1:
PRODUCTS DISTRIBUTED FY'86 AND FY'87 (CONT'D)

3.5 Meetings/Conferences

IITRI/RAC personnel attended the following meetings/conferences during the contract period.

EOS/ESD Symposium, Philadelphia, PA, 2-4 October 1984.

SAE Electronics Reliability Subcommittee Meeting, Williamsburg, VA, 6-7 November 1984.

R&M Symposium, Philadelphia, PA, 21-24 January 1985.

GE/AESD Component Seminar, Utica, NY, 13 August 1985.

EOS/ESD Symposium, Minneapolis, MN, 10-12 September 1985.

American Society of Metals (ASM) Annual Conference, Toronto, Canada, 14-18 October 1985.

Defense Technical Information Center (DTIC), User Conference, Alexandria, VA, 22-25 October 1985.

The 1985 AFSC/AFLC Reliability and Maintainability Workshop, Wright-Patterson AFB, OH, 13-15 November 1985.

Annual R&M Symposium, Las Vegas, NV, 27-30 January 1986.

Consultant and Exchange Program Mission, Lillestrom, Norway, 10 December 1986.

R/M Symposium, Philadelphia, PA, January 1987.

IPC Meeting, Atlanta, GA, 29 March 1987 - 3 April 1987.

SAE Electronics Reliability Committee Meeting, Phoenix, AZ, 6-7 May 1987.

MAP/TOP User Group, Pittsburgh, PA., May 1987

Joint IPC-EIA on Surface Mount Soldering, Boston, MA, 9-10 July 1987.

Military/Industry Working Group, Dallas, TX, 22-23 July 1987.

DoD-STD-2000 Workshop, Philadelphia, PA, 29 September 1987.

Computer Systems Engineering Conference, Boston, MA., September 1987

Government Open Systems Interconnect Profile Conference, Gaithersburg, MD., September 1987

GIDEP, 22-24 October 1987.

3.6 Training Courses

The Reliability Analysis Center has presented four different Training Courses throughout the performance of this contract. They are:

Design Reliability Training Course

This course is specifically tailored for the instruction of electrical circuit design engineers and managers who have had little or no previous reliability training. It introduces the basic concepts and

theory of reliability engineering along with rudimentary mathematical relationships and emphasizes the practical application of reliability tools which can be used by the designer. The course is designed to allow a maximum of individual participation and to foster the application of the demonstrated principles to specific reliability problems experienced by designers.

Practical Statistical Analysis Training Course

This course is structured specifically to help the non-statistician who needs to apply statistical methods or understand their use in technical reports. We stress that a basic understanding of probability and of basic statistics is an advantage. It introduces the non-specialist to statistical concepts with a minimum of mathematics and explains (by example) some popular methods applicable to practical reliability studies. It also provides a basic understanding of the statistics commonly used in technical reports and supplies the background and references to more advanced methods, while indicating their potential.

Electronic Equipment Testability Training Course

This course has been structured specifically to help management level and engineering personnel develop an understanding of the concepts, benefits, and implementation of testability as a design discipline. The course emphasizes military procurement activity provisions in both management and technical endeavors. It encompasses the latest state-of-the-art technology and methodology and it ends with an open discussion workshop in which the students are encouraged to present problems based upon their own particular concerns and needs.

Worst Case Analysis Training Course

This tutorial addresses the circuit design problem in its entirely by considering all of the worst conditions and factors, both electrical and environmental, which might occur singularly or in combination, during the effective life span of the equipment. It defines, discusses, and compares in detail three numerical approaches to Worst Case Analysis: Extreme Value Analysis (EVA), Root Sum-Squared (RSS), Monte Carlo (MC) and provides guidelines for the accomplishment of a Worst Case Analysis, including block diagramming and circuit partitioning, use of circuit attributes and interface specifications, parts applications, worst case stress analysis, circuit models and equations and circuit simulations.

This tutorial also addresses computer aided Worst Case Analysis, its advantages and limitations, available computer programs and provides examples of two programs. It includes discussions of what to do when models break down, the generation of a formal report and worst case management and control.

Three signficant events occurred involving the RAC Training Courses. The 100th presentation of the Design Reliability Training Course was held at the Holiday Inn, Syracuse, NY, 27-30 October 1986. The Electronic Equipment Testability and the Worst Case Analysis Training Courses were developed and presented. There were 51 presentations of RAC Training Courses to 1,532 students.

Location	Dates	Attendance	Type	Course
Tadiran, IEI, Ltd. Tel Aviv, Israel	10/29-11/2/84	34	on-site	RDTC
Burroughs Corp. Carlsbad, CA	11/05-11/08/84	34	on-site	PSATC
Naval Weapons Center	11/13-11/16/84	37	open	PSATC
Sheraton-Twin Towers Orlando, FL	12/03-12/06/84	15	open	PSATC
Sheraton-Twin Towers Orlando, FL	12/10-12/13/84	50	open	RDTC
Naval Avionics Center Indianapolis, IN	01/07-01/10/85	68	on-site	RDTC
Burroughs Corp. Paoli, CA	01/14-01/17/85	29	on-site	PSATC
Israel Aircraft Israel	02/04-02/07/85	53	on-site	RDTC
Naval Avionics Center Indianapolis, IN	02/19-02/22/85	53	on-site	RDTC
Town & Country Hotel San Diego, CA	03/03-03/07/85	47	open	RDTC
Fleet Analysis Center Corona, CA	03/18-03/21/85	24	on-site	RDTC
Hazeltine Corp. Commack, NY	04/15-04/19/85	40	on-site	RDTC
Naval Avionics Center Indianapolis, IN	04/29-05/02/85	34	on-site	RDTC
Harley Hotel Enfield, CT	05/13-05/16/85	42	open	RDTC
Tadiran, IEI, Ltd. Tel Aviv, Israel	06/10-06/13/85	35	on-site	RDTC
Boeing Military AC Wichita, KS	06/24-06/27/87	35	on-site	RDTC

Location	Dates	Attendance	Type	Course
Harley Hotel Enfield, CT	07/22-07/25/85	17	open	PSATC
Sheraton Inn Syracuse, NY	08/06-08/08/85	15	open	EETTC
Clarion Hotel Denver, CO	09/23-09/26/85	33	open	RDTC
Clarion Hotel Denver Airport Denver, CO	10/7-10/10/85	12	open	PSATC
Naval Avionics Center Indianapolis, IN	10/7-10/10/85	55	on-site	DRTC
Virginia Beach Plaza Virginia Beach, VA	10/8-10/10/85	28	open	EETTC
Tadiran Tel Aviv, Israel	10/21-10/24/85	22	on-site	DRTC
Abbott Labs. North Chicago, IL	11/17-11/22/85	18	on-site	DRTC
Sheraton-Twin Towers Orlando, FL	12/9-12/12/85	8	open	PSATC
Sheraton-Twin Towers Orlando, FL	12/9-12/12/85	37	open	DRTC
PTE, Ltd. Singapore	2/3-2/7/86	25	on-site	EETTC
Israel Aircraft Ashdod, Israel	2/17-2/20/86	33	on-site	DRTC
Sheraton-Twin Towers Orlando, FL	2/26-2/28/86	22	open	EETTC
The Clarion Hotel Millbrae, CA	3/3-3/6/86	22	open	DRTC
Virginia Beach Plaza Virginia Beach, VA	3/24-3/27/86	24	open	WCATC
Boeing Seattle, WA	4/7-4/10/86	49	on-site	DRTC

Location	Dates	Attendance	Type	Course
Sheraton Inn Syracuse, NY	4/7-4/10/86	13	open	PSATC
Virginia Beach Plaza Virginia Beach, VA	6/9-6/12/86	45	open	DRTC
Sheraton Inn Syracuse, NY	6/23-6/26/86	23	open	WCATC
Clarion Hotel/ Denver Airport Denver, CO	9/7-9/10/86	10	open	PSATC
Sherton Inn Syracuse, NY	9/19-9/21/86	23	open	EETTC
Marriott Hotel Minneapolis, MN	10/6-10/8/86	16	open	DRTC
Holiday Inns Syracuse, NY	10/27-10/30/86	43	open	DRTC
Eaton Corporation Deer Park, NY	11/11-11/13/86	35	closed	DRTC
Town & Country Hotel San Diego, CA	11/18-11/20/86	23	open	EETC
Sheraton Twin Towers Orlando, FL	12/8-12/11/86	33	open	DRTC
Sheraton Twin Towers Orlando, FL	12/8-12/11/86	7	open	PSATC
Town & Country San Diego, CA	3/2-3/5/87	43	open	DRTC
Sheraton Orlando, FL	5/19-5/21/87	19	open	TPT
Virginia Beach Plaza Hotel Virigina Beach, VA	6/8-6/11/87	38	open	DRTC
Virginia Beach Plaza Hotel Virigina Beach, VA	6/8-6/11/87	9	open	PSATC

Location	Dates	Attendance	Type	Course
Virginia Beach Plaza Hotel Virginia Beach, VA	7/14-7/16/87	33	open	TPT
Sheraton Syracuse, NY	8/17-8/20/87	20	open	WCATC
Clarion Hotel Denver, CO	9/14-9/17/87	38	open	DRTC
Clarion Hotel Denver, CO	9/14-9/17/87	11	open	PSATC

4.0 SPECIAL STUDIES

During this Contract, 41 user funded special studies were conducted. A brief summary of each can be found in Appendix D.

5.0 INTERNAL R/D EFFORTS

The RAC Management Information System (MIS) is now 100% operational and is far exceeding our initial expectations. This system represents a significant advance for the baseline RAC operations. The direct cost savings alone should pay back the initial investment within 12 months, and the indirect benefits of the improved information resource are probably several times more valuable than the direct savings.

RAC has taken steps to implement and maintain its mailing list in-house. This function has previously been subcontracted to a bulk-mailing service. It is planned to integrate the mailing list with present automated order processing and sales records. This will permit selective mailings based on sales history; for example promoting a new product to previous customers who have purchased related products. Preliminary studies show reductions in labor savings and postage costs to provide pay back on the transitioning cost in less than 6 months.

A new telephone number solely for technical inquiries was installed. This should provide improved access and responsiveness to user needs.

6.0 FINANCIAL SUMMARY FY'86

Operating expenditures for carrying out the Reliability Analysis Center's on-going operational functions and satisfying individual user inquiry and study requirements for the contract totalled $11,865,480. Funding to date from all sources amounted to 11,701,010. Listed below is a summary of funding to date from all sources:

Special Projects	$8,535,682
Training Courses	845,124
Funded Inquiries	35,485
User Services	752,319
DTIC Funding	1,532,400

7.0 INFORMATION FROM IAC USERS

7.1 User Feedback on IAC Services

More than 5,000 books were ordered during the contract. There were 41 special studies undertaken for Government customers and 51 training course were presented to 1,532 students. During this contract 48% of customers were "repeats". This high level of activity and the number of repeat users is a strong indication of user satisfaction. Although unsolicited user feedback is difficult to obtaining Appendix C contains that which was received.

8.0 RAC PROFESSIONAL STAFF

The following technical professional staff members were assigned to the Reliability Analysis Center operations during the contract. Titles and specialty areas are included.

S. Flint, Manager of Research
RAC Technical Director

R. Arno, Associate Engineer
Nonelectronic Parts Reliability

E. Bolden, Research Engineer
Systems Reliability

C. Carroll, Research Engineer
Systems Design and Integration

J. Carey, Research Assistant
Data Acquisition

C. Cox, Associate Data Analyst
User Awareness

D. Crossland, Supervisor Administrative Services
Office Management

W. Crowell, Research Assistant
Data Acquisition

W. Denson, Research Engineer
Electrostatic Discharge, VLSI Reliability

W. Doremus, Senior Engineer
Production Readiness

D. Dylis, Associate Engineer
Nonelectronic Parts Reliability, Systems

K. Free, Assistant Programmer Analyst
Systems Analysis

N. Fuqua, Research Engineer
Component and Systems Reliability, Training Course Instructor

M. Hartz, Senior Engineer
Statistics, Mathematical Modeling

RAC PROFFESIONAL STAFF (CONT'D)

K. Henniger, Technical Writer/Editor
Systems Analysis

J. Hill, Assistant Engineer
Depot Readiness

K. Huss, Research Engineer
Systems Reliability

J. Irving, Research Programmer Analyst
RACIS Coordinator

S. Kus, Product Assurance Consultant
Systems Reliability, Training Course Instructor

K. Lindquist, Division Adminstrative Assistant II
Systems Analysis

D. Mahar, Assistant Engineer
Microcircuit Reliability

N. Pfrimmer, Administrative Assistant
Training Courses and Workshops

M. Priore, Associate Engineer
Microcircuit Reliability

B. Radigan, Senior Engineering Technician
Systems Analysis

D. Rash, Assistant Engineer
Microcircuit Reliability

J. Reed, Associate Data Analyst
Depot Readiness

R. Sadlon, Assocate Engineer
Mechanical Reliability

J. Saporito, Associate Engineer
Systems Reliability, Testability

D. Tyler, Associate Engineer
FMEA, FMECA, Systems Reliability

RAC PROFESSIONAL STAFF (CONT'D)

R. Wanner, Associate Programmer Analyst
RACIS Coordinator, Depot Readiness

R. Wawrzusin, Research Engineer
CAD/CAM/CIM Depot Readiness

S. Wheat, Assistant Programmer Analyst
Systems Analysis

J. Wilbur, Research Engineer
RAC Training Courses

APPENDIX A:

SAMPLE TECHNICAL/BIBLIOGRAPHIC INQUIRIES

RAC Service Request Report
Created on Feb 3, 1988

Date : 03/01/1987 User: mgp
Type : Bibliographical, Customer to RAC, Service Request Bib. (Old)(SRR-B)
Subject : Rel. Prediction programs available commercially.
Rich Bradley (Custmer # 25933)
Quantum Data
Mechanical Engineering
2111 Big Timber Rd.
Elgin, IL 60123

Date : 03/01/1987 User: mgp
Type : Bibliographical, Customer to RAC, Service Request Bib. (Old)(SRR-B)
Subject : RAC publications available & RADC TR's.
Sam Canale (Custmer # 25936)
Rockwell International
Rel. Dept.
12214 Lakewood Blvd.
Downey, CA 90241

Date : 03/01/1987 User: mgp
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : Effect of error correction circuitry on rel.
Dick Starsynski (Custmer # 25937)
Ball Aerospace
Systems Div.
Boulder, CO 80306

Date : 03/01/1987 User: mgp
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : 217 Prediction: Nonelectronics.
David Orwig (Custmer # 25938)
Naval Air Test Center
Washington, DC 20008

Date : 03/01/1987 User: mgp
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : Impact of NONOP periods on IC.
Rita Greco (Custmer # 25939)
Alcoa Technical Center
Alcoa Center, PA 15069

RAC Service Request Report
Created on Feb 3, 1988

Date : 03/01/1987 User: mgp
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : Reliability of GAAS Fets.
Brian Kumataka (Custmer # 25940)
Northrop
ESD
600 Hicks Rd.
Rolling Meadows, IL 60008

Date : 03/01/1987 User: mgp
Type : Bibliographical, Customer to RAC, Service Request Bib. (Old)(SRR-B)
Subject : Status of MIL-HDBK-XXX, Testability.
George Shook (Custmer # 25941)
Midland Ross
Grines Div.
Urbana, OH 43078

Date : 03/01/1987 User: mgp
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : Definition of ENV PI Factors.
Eugene Kelsey (Custmer # 25942)
PRC
PO Box 211
Jolan, CA 93928

Date : 03/27/1987 User: mgp
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : D of memory devices.
Dr. Spandorfer (Custmer # 25956)
Arthur D. Little Incorporated
Washington, DC 20024

Date : 04/01/1987 User: gdc
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : NRPS-1.
Roy Weir (Custmer # 9793)
Arinc Research
4055 Hancock St.
San Diego, CA 92110

RAC Service Request Report
Created on Feb 3, 1988

Date : 04/01/1987 User: whc
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : Video tapes.
Terry W. Jacobson (Custmer # 14146)
Cray Research
Hwy. 178
North Industrial Park
Chippewa Falls, WI 54729

Date : 04/01/1987 User: gdc
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : 217 Predictions.
Karen L. Cromer (Custmer # 17013)
TRW
2868 Running Pump Lane
Herndon, VA 22071

Date : 04/01/1987 User: gdc
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : Software for reliability engineering.
Philip Reece (Custmer # 18055)
Saint John Shipbuilding Limited
PO Box 970
St. John, N.B., E2l 4E5 Canada

Date : 04/01/1987 User: gdc
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : Circuit Board Reliability.
Ed Hoover (Custmer # 21797)
Digital Equipment
146 Main St.
Ml03-3/H13
Maynard, MA 01754

Account Member

RAC Service Request Report
Created on Feb 3, 1988

Date : 05/26/1987 User: gdc
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : Diskete verision of MRAP/SRAP
Robert E. Raymond (Custmer # 13268)
Allied Bendix
Aerospace Encd., Dept. 862
717 N. Bendix Dr.
South Bend, IN 46620

MRAP/SRAP Subscriber

Date : 05/27/1987 User: gdc
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : the diskette verison of MRAP/SRAP
Martin Gold (Custmer # 25737)
Teledyne Ryan Electronics
Dept. 365
PO Box 23505
San Diego, CA 92123

Information Pack sent on May 27, 1987.
Comments: CALL WHEN MRAP FLOPPY OUT. TYPE-O- IN RAC NEWSLETTER ON POWERTONICS
PHONE NUMBER (APRIL 87)

Date : 05/27/1987 User: gdc
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : MRAP/SRAP and MIL-STD-1562
David T. Greenbalt (Custmer # 25739)
Tempo Instruments
87 Modular Ave.
Commack, NY 11725

Information Pack sent on May 27, 1987.

Date : 05/28/1987 User: gdc
Type : Technical, Customer to RAC, Service Request Technical (Old)(SRR-T)
Subject : failure rates and failure modes for electronic heaters
David Hubband (Custmer # 22165)
General Binding
1101 Skokie Blvd.
Northbrook, IL 60062

Information Pack sent on May 28, 1987.
Comments: REFERED TO BOB A.

APPENDIX B:

RAC DATABOOK CROSS REFERENCE

Component Reliability Databooks

MDR-14	Hybrid Circuit Data - 1980
MDR-15	Digital Evaluation and Generic Failrue Analysis Data - Vols. I and II - 1980
MDR-18	Memory/LSI Data - 1982
MDR-19	Digital SSI/MSI Data - 1984
MDR-21	Trend Analysis Databook - 1985
MDR-21A	Field Experience Databook - 1985
MDR-22	Microcircuit Screening Analysis
MDR-22A	Microcircuit Screening Analysis
DSR-3	Transistor/Diode Data - 1980
NPRD-3	Nonelectronic Parts Reliability Data - 1985 Printed Copy
FNPRD-3	Nonelectronic Parts Reliability Data - 1985 Floppy Disk Copy (IBM Compatible)
VZAP-1	Electrostatic Discharge Susceptibility Data - 1983
NONOP-1	Nonoperating Reliability Data - 1987

Equipment Databooks

EERD-1	Electronic Equipment Reliability Data - 1980
EEMD-1	Electronic Equipment Maintainability Data - 1980

Handbooks

RDH-376	Reliability Design Handbook - 1976
MFAT-1	Microelectronic Failure Analysis Techniques Procedural Guide - 1981
NPS-1	Analysis Techniques for Mechanical Reliability -1985

State-of-the-Art Report

SOAR-1	ESD Protective Materials and Equipment: A Critical Review
SOAR-2	Practical Statistical Analysis for the Reliability Engineer
SOAR-3	IC Quality Grades: Impact on System Reliability and Life Cycle Costs
SOAR-4	Confidence Bounds for System Reliability
SOAR-5	Surface Mount Technology: A Reliability Review
SOAR-6	ESD Control in the Manufacturing Environment

Technical Reliability Studies

TRS-1	Microcircuit Screening Effectiveness
TRS-2	Search and Retrieval Index to IRPS Proceedings - 1968 - 1978
TRS-2A	Search and Retrieval Index to IRPS Proceedings - 1979 to 1984
TRS-3A	EOS/ESD Technology Abstracts
TRS-4	Search and Retrieval Index to EOS/ESD Proceedings - 1979 to 1984
TRS-5	Search and Retrieval Index to ISTFA Proceedings - 1978 to 1985

Electrostatic Overstress/Electrostatic Discharge Symposium Proceedings

EOS-1	1979 Proceedings
EOS-2	1980 Proceedings
EOS-3	1981 Proceedings
EOS-4	1982 Proceedings
EOS-5	1983 Proceedings
EOS-6	1984 Proceedings
EOS-7	1985 Proceedings

MRAP/SRAP

MRAP/SRAP	Microcircuit Reliability Assessment Program/ Semiconductor Assessment Program
FMRAP	Diskette of MRAP Data (IBM PC Compatible) (Includes MRAP/SRAP Basic Subscription)

Products for Personnal Computers

RAC-NRPS	Nonoperating Reliability Prediction Software

APPENDIX C:

USER FEEDBACK ON IAC SERVICES

Westinghouse Electric Corporation
Defense Group

Defense and Electronic
Systems Center
Integrated Logistics Support

1111 Schilling Road
Hunt Valley Maryland 21030

8 July 1986

Reliability Analysis Center
RADC/RAC
Griffiss AFB, NY 13441

Dear Staff:

We would like to receive the RAC Newsletter regularly as we find many RAC publications useful for our work here at Westinghouse.

Please add us to your mailing list and send the newsletter to:

Westinghouse Electric Corp.
ATTN: N. Reger
TIC-HV, MS 7008
111 Schilling Rd.
Hunt Valley, Md. 21031

Thank you very much.

Sincerely,

Nancy Reger
Technical Librarian

APPENDIX D:

RAC SPECIAL STUDIES

Title ..... : SYSTEM RELIABILITY BOUNDS FROM TIME TRUNCATED SUBSYSTEM DATA

IITRI Project Number ... : A06101A065
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : ROME AIR DEVELOPMENT CENTER
Address ..... : RADC
GRIFFISS AFB, NY 13440
Technical Representative : J. Klion

Performance Period ..... : 25 April 1986 to 30 September 1987
Contract Value ..... : $10,800.00

Project Summary

The objective of this effort was to research, develop and test practical techniques for computing system reliability bounds from subsystem testing, where some or all of the data is time truncated.

The techniques are to be used by engineers/engineering managers. The study was conducted with the final user in mind and the final report structured for the non-statistician.

The method for developing bounds on system failure rate involved a literature search to determine solution candidates. Once promising candidate methods were identified, a simulation experiment was executed to examine the methods' performance with respect to several criteria.

This study built on a previous Reliability Analysis Center study (ROM85), which considered Type II censoring, whereas this study considered Type I consoring.

An independent simulation testing approach was used to compare five methods for calculating an upper bound on system failure rate. The simulator allowed us to assess and compare performance by comparing the actual confidence level achieved with the confidence level desired. The simulator also reveals the distribution of the bounds.

The study allowed us to decide in favor of one of five methods. We recommend that the adaptation of the Approximately Optimal method "AO I" be used to calculate upper confidence bounds on system failure rates. This method was recommended because:

- o It is the most accurate of the methods examined
- o It is the least variable of the methods examined
- o It is practical to implement

Title ..... : R/M SUPPORT FOR AIRPORT SURFACE DETECTION EQUIPMENT(ASDE-3)

IITRI Project Number ... : A06102
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : FEDERAL AVIATION ADMINISTRATION
Address ..... : WASHINGTON, DC
Technical Representative : A. MAILLETT

Performance Period ..... : 25 April 1984 to 1 July 1985
Contract Value ..... : $115,000.00

Project Summary

The objective of this project was to develop the Reliability and Maintainability (R&M) Specifications and evaluation criteria to be included in the overall ASDE-3 ground detection radar system specification for the Federal Aviation Administration, located in Washington DC. The R&M specifications submitted to the FAA included MTBF, MTTR, R&M management program and reliabilty test planning.

R/M expertise in setting evaluation criteria for the bidding process. The ASDE-3 radar system will ultimately provide ground (and low altitude) surveillance for commercial airports. Also provided was technical assistance to FAA in review of the ASDE-Radar proposals from various contractors. In particular, RAC reviewed and answered R&M questions concerning ASDE-3 proposals submitted by prospective bidders to assure that their technical approaches are responsive to the FAA ASDE-3 Radar required R&M tasks.

Title ..... : TWO-LEVEL VS. THREE-LEVEL MAINTENANCE STUDY ON UH-60A BLACKHAWK

IITRI Project Number ... : A06103
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY/AVSCOM
Address ..... : AVSCOM
ST. LOUIS, MO.
Technical Representative : LOUIS NERI

Performance Period ..... : 30 May 1984 to 14 December 1985
Contract Value ..... : $125,000.00

Project Summary

The objective of this study for the U.S. Army AVSCOM was to determine the feasibility of a two-level system of maintenance for the UH-60A helicopter. Presently, the Army uses a three-level maintenance system. This study identified problems the Army faces in adopting a two-level maintenance system. This study established the database necessary to analyze the current three-level system and to determine a quantitative baseline in terms of life cycle cost. Specifically, the study tasks consisted of the following:

1) Established a UH-60A Reliability, Availability and Maintainability (RAM)/Integrated Logistic Support (ILS) database that clearly defined the current Aviation Intermediate Maintenance (AVIM) level requirement and actual Army practice relative to engines, airframe structure, avionics, and aircraft subsystems.

2) Analyzed the database to determine specific Aviation Intermediate Maintenance (AVIM) Tasks and required support equipment, skill levels, Military Occupational Specialities (MOS's), facilities, and spare parts relative to these tasks.

3) Identified inherent aircraft design features that cause the AVIM level requirement. Investigated current practice within U.S. Army UH-60A organizations to determine actual AVIM level activity and underlying underlying factors, problems, and consequences of current practice.

4) Established a quantitative Life Cycle Cost baseline relative to the existing three-level system as currently practiced within existing Army units and compatible with the existing logistics support concept for the UH-60A fleet as currently deployed in CONUS and Europe.

Title ..... : RELIABILITY DATA COLLECTION FOR SELECTED AIRCRAFT AVIONICS

IITRI Project Number ... : A06104
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : AFLC
WRIGHT-PATTERSON AFB, OH.
Technical Representative : NANCY CLEMENTS

Performance Period ..... : 1 October 1984 to 30 August 1985
Contract Value ..... : $128,900.00

Project Summary

The objective of this effort was to augment an existing ASD database on Avionics with life cycle reliability data, placing particular emphasis on the development and early production phases. In particular, data was collected from specification requirements contractor, R/M program tasks including prediction, assessment, and the various testing activities utilized for demonstrating reliability compliance and/or establishing equipment acceptance. Such data will be obtained primarily from the System Program Offices, prime contractors, lower tier contractors and vendors, and Test and Evaluation (T&E) functions. Collection of operation/maintenance data is not considered to be within the scope of this effort.

The data collection encompassed all previously unfunded AN-type nomenclature avionic equipment and assemblies down to the LRU level specificed by the Avionics Planning Baseline. Collection consisted of MTBF numberics along with necessary descriptive backup (item characteristics) and failure information. Collected data was reduced as necessary to extract and classify the data elements required by the ASD avionics database record structure.

Title ..... : NAC R&M STANDARDS DEVELOPMENT PROGRAM

IITRI Project Number ... : A06135
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US NAVY
Address ..... : NAVAL AVIONICS CENTER
INDIANAPOLIS IN. 46218
Technical Representative : R. BLONDIN

Performance Period ..... : 1 January 1985 to 30 September 1987
Contract Value ..... : $441,378.00

Project Summary

This effort, performed for the Naval Avionics Center (NAC), was to develop twenty-three R&M Standards. These standards are part of a larger series of working level reliability and maintainability documents prepared in specific areas of interest for use by NAC program managers, and project design engineers.

The NAC has undertaken a long-range effort to institute formal reliability and maintainability program elements as part of all their system/equipment development acquisition programs. To implement this program, NAC is develpoing a series of internal standards that translate general R&M standards provisions into working level policy, procedural, and guidance information.

The Reliability Analysis Center (RAC) has been assisting NAC in producing these internal standards. The following is a list of standards developed by the RAC:

R101 - Reliability Program Plan
R102 - Monitor/Control of Subcontractors and Suppliers
R103 - Reliability Program Reviews
R104 - Failure Reporting, analysis, and Correction Action System (FRACAS)
R105 - Failure Review Board
R106 - Field Data Tracking
R200.2 - Service Use Profile
R201 - Reliability Modeling
R202 - Reliability Allocations
R203 - Reliability Predictions
R204 - Failure Modes Effect and Critical Analysis (FMECA)
R206 - Electronic Parts/Circuits Tolerance/Worst-case Analysis
R207.4 - Purchased Item Verification Tests (PIVT)
R208 - Reliability Critical Items
R210 - Fault Tree Analysis
R211 - Thermal Analysis
R217 - Human Reliability Analysis
R218 - Testability/BIT Reliability Analysis

Title ..... : NAC R&M STANDARDS DEVELOPMENT PROGRAM

R301.1 - TEMP
R302 - RDGT Program
R303 - RQT Program
R304 - PRAT Program
R305 - Preproduction (First Article) Test

Title ..... : RAM AND SOFTWARE ANALYSIS OF EPCS

IITRI Project Number ... : A06106
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US.S ARMY AMCCOM
Address ..... : SMCAR-LCA-PD
DOVER, NJ. 07081
Technical Representative : WILLIAM DOREMUS

Performance Period ..... : 1 October 1984 to 30 September 1985
Contract Value ..... : $40,000.00

Project Summary

The primary objectives of this study were to prepare a checklist, collect data, and perform an evaluation of Army Ammunition Plants for the purpose of evaluating its Relability, Availability and Maintainability, Hardware and Software present status. From "lessons learned," recommendations were included in a final report that proposed corrective procedures which could enhance EPCS high readiness capability after long periods of storage (up to 20 years). Hardware improvements provided for better fault detection/isolation procedures, instructional documentation, spare parts control, training procedures/aids, failure data collection procedures, and skill requirements. Software improvements included better management, Q&A and maintenance, media control procedures, back up documentation storage handling code audits and better configuration control methods.

It was determined that by including these recommended RAM improvements EPCS readiness posture would allow an AAP to reactivate after long periods of storage (up to 20 years) and be ready to produce ammunition within 60 days after reactivation.

Title ..... : AIRCRAFT THRESHOLD VALIDATION AND DATA ANALYSIS

IITRI Project Number ... : A06109
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY
Address ..... : AVSCOM/RADC
CORPUS CHRISTI, TX.
Technical Representative : MORRIS WILLIAMS

Performance Period ..... : 20 September 1984 to 20 April 1985
Contract Value ..... : $132,000.00

Project Summary

The Army, as part of their Reliability Centered Maintenance/Or Condition Maintenance (RCM/OCM) maintenance improvement activities, conducts a program to evaluate the condition of bearings used in helicopter engines and transmissions. As part of this program, large volume of data must be processed to determine the need for reconditioning. Due to the large volume and the continous flow of data, it is imperative that the data be processed automatically in order to reduce manhours and increase processing efficiency. An automated bearing data analysis process must be available and operational in a timely manner.

The objectives of this project were to :

1) Develop and document the threshold validation procedure for the Airframe Condition Evaluation (ACE) program.

2) Develop and implement a special purpose data analysis package on a microcomputer system for reliability and maintainability analysis.

3) Integrate the ACE validation criteria and selected bearing condition data into the RCM database for use in the application of the automatic MSG-3/RCM Decision Logic Process currently under development.

Title ..... : PRODUCTION READINESS ENHANCEMENT PROGRAM (PREP)

IITRI Project Number ... : A06110
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : U.S. ARMY AMCCOM
Address ..... : SMCAR-LCA-PD
DOVER NJ. 07081
Technical Representative : WILLIAM DOREMUS

Performance Period ..... : 3 December 1984 to 30 September 1985
Contract Value ..... : $914,200.00

Project Summary

The objective of the Production Readiness Enhancement Program (PREP) was to develop a handbook for the acquistion of Electronic Process Control Systems (EPCS) for Army Ammunition Plants. This handbook has been written for the Production Base Modernization Agency Engineer who will use it to implement correct procedures involving EPCS acquistion during its life cycle phases. The EPCS life cycle phase activities generated include the traditional phases as well as planning for eventual storage, the storage phase itself, and finally, the reactivation phase (after long periods of dormancy, plants producing ammunition are required to mobilize and produce ammunitionwithin 60 days after reactivation). The established procedures include scope of work tasks, specifications, contract data requirements lists, Data Item Description and other government MIL-STD's, and directions which tend to enhance EPCS hardware and software acquistion by promoting system readiness capabilities.

The next step in the development of the handbook was to test its usage in the field and from "lessons learned" to update its content.

A second objective was to set up a PREP Network which includes purchasing, installing, and developing the software for nine personal IBM computers located at various field locations and to implement PREP handbook procedures via a communications network.

Title ..... : ASSESSMENT OF PRODUCT IMPROVEMENT (PI) AND TECHNOLOGY INSERTION (P3I) POLICY AND PROCEDURES

IITRI Project Number ... : A06112
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : U.S. ARMY
Address ..... : HQDARCOM/RADC
ALEXANDRIA, VA.
Technical Representative : J.O'BRIEN

Performance Period ..... : 14 January 1985 to 27 May 1985
Contract Value ..... : $161,500.00

Project Summary

The purpose of this effort was to assess and evaluate Product Improvement (PI) policies and procedures relative to (1) integrating of PIP/P3I management with existing program management, (2) planned balance of PIP/P3I funding with total Army materiel initiatives, and (3) improving technology insertion through better integration of Lab R&D requirements definition, and program planning.

The objective of this project was to develop specific recommendations and action plans for effecting necessary changes.

RAC performed the following specific activities:

1) Survey/review existing PIP/P3I policy and procedures and evaluated their acceptability in light of the numerous criticisms leveled at the program.

2) Analyze and summarize results, and consolidate to identify and clarify systemic problems.

3) Develop alternative approaches and plans to resolve problem areas.

4) Develop specific recommendations and draft language for revision of AR 70-15 to incorporate necessary changes.

RAC prepared and submitted (a) formal briefing charts and supporting documentation for scheduled briefings, and (b) a final report that presents the findings of the PI assessment.

Title ..... : ELECTROSTATIC DISCHARGE CONTROL PROGRAM

IITRI Project Number ... : A06114
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US NAVY
Address ..... : NAVSEA/ CODE 06C31
WASHINGTON, DC. 20362
Technical Representative : DON CROSS

Performance Period ..... : 12 November 1984 to 30 November 1987
Contract Value ..... : $221,036.00

Project Summary

RAC has provided technical support to the Navy ESD program since 1979. The program objectives were to develop and promulgate guidance and procedures to minimize EOS/ESD damage, to conduct reliability/failure anlyses of Navy systems and equipments to assess ESD sensitivity, and to develop an awareness program for EOS/ESD.

Activities included analysis of ESD sensitivity thresholds of selected Trident equipments, providing quick reaction technical support, conducting facility surveys and providing ESD awareness briefings and training. Technical support was provided on the full spectrum of engineering problems related to ESD such as requirements interpretation, protective materials and equipments, handling procedures, failure analysis and design guidance.

Previously, assistance was provided in preparing and coordinating ESD-related military specifications (DoD STD-1686) and handbooks (DoD Handbook 263), developing the Navy ESD program, producing awareness training materials and conducting presentations, investigating ESD - caused latent failures, conducting facility ESD susceptibility surveys, and performing sensitivity analyses on equipments and modules. Various Navy installations have been trained in ESD, along with a number of contractor organizations. Forty-five equipments aboard the SSBN726 class submarine have been analyzed for their ESD suscepet-ibility. Other special study tasks included development of a failure analysis procedure to isolate ESD caused failures; investigaton into transient suppressors for ESD mitigation; investigation into electro-static charges during IC fabrication (on long term reliability); and development of improved text methods for determining the ESD susceptibility of electronic components.

Title ..... : M753 FUZE ANALYSIS

IITRI Project Number ... : A06115
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY
Address ..... : ARDC
DOVER, NJ.
Technical Representative : CHARLES MERIK

Performance Period ..... : 15 April 1985 to 30 September 1987
Contract Value ..... : $161,750.00

Project Summary

This effort was performed for the U.S. Army Nuclear Systems Divisionat Dover, NJ, and involved the development of a stockpile surveillance database. The database was relocated on the Harry Diamond Labs (HDL) VAX computer. In addition, the data base and analysis techniques pursued were discussed; this led to a data base restructuring including only those parameters deemed important, which reduced long run-times. The development of techniques to track parameters and fuzes over time was designated of primary importance. The implementation strictly uses the FORTRAN HOL interface (FDML), per customer requirements.

Title ..... : FEEDBACK ANALYSIS NETWORK PHASE II (FAN)

IITRI Project Number ... : A06116
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY AMCCOM
Address ..... : AMSME-QAR (D)
DOVER NJ. 07801
Technical Representative : DAVID IMHOF

Performance Period ..... : 18 January 1985 to 30 December 1985
Contract Value ..... : $559,730.00

Project Summary

The objective of this effort was to assist the Army in the development of the Feedback Analysis Network (FAN), which integrates field failure data and cost data from numerous existing data sources into a single computerized system. This integration provides the capability of reporting the prioritized failure activity and failure-related cost of systems and subsystems. The FAN system has the capability of generating search reports, and pre-defined reports. The system will be flexible enough to accomodate changing formats and additional reports.

Phase II involves the actual design/implementation of the data-base scoped under Phae I, the Definition Phase. The database was developed on the AMCCOM PAD VAX computer using the Oracle Database Management System.

The following documents were delivered: a Systems Design Document, a Program Description Document, and a Database Operations Manual.

Title ..... : LOGISTICS READINESS (RAM) SYSTEM

IITRI Project Number ... : A06117
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY
Address ..... : AMCCOM
DOVER, NJ.
Technical Representative : L,S, GOLDSMITH

Performance Period ..... : 1 October 1984 to 1 March 1985
Contract Value ..... : $2,022,941.00

Project Summary

This project supports the U.S. Army Armament R&D Center (ARDC) Battle-field and Support Division through the development of a Logistic Readiness (RAM) System capable of achieving a high level of field operational readiness in a cost-effective manner. This system supports the materiel logistic process by establishing and maintaining a current and readily accessible data base of regulations, requirements, specification and RAM characteristics relative to component and materiel items in the Army's inventory. The overall function of the RAM system is to provide a paperless management tool which reduces the adminstrative time required to issue and monitor a request for materiel.

The initial phase of this effort was a six month investigation which resulted in a detailed functional design of the system that will provide the necessary RAM visibility and control. The second phase of the RAM system currently under development provides for the implementation of the user interface where electronically generated forms will be routed concurrently to all required functions where they will be accepted, held or rejected electronically and will be filed in a data base for easy retrieval and report generation.

Title ..... : COORDINATION MEETING PROPOSED REVISION D TO MIL-P-55110 AND PROPOSED REVISION E TO MIL-STD-275

IITRI Project Number ... : A06118
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : RADC/RBER
GRIFFISS AFB, NY. 13441
Technical Representative : EUGENE BLACKBURN

Performance Period ..... : 29 October 1984 to 30 September 1987
Contract Value ..... : $34,400.00

Project Summary

The objective of this project was to research and provide printed wiring board reliability techniques and standards, primarily through attendance at professional seminars and specification review/preparation/update meetings.

As a consultant to RADC, Mr. John McCormick attended the Institute for Interconnecting and Packaging Electronic Circuits (IPC) Fall meeting and a meeting on MIL-P-28809, Printed Wiring Assemblies to represent RADC's interests. The initital draft of the proposed revision of MIL-P-13949, Rigid Printed Wiring Materials, was reviewed and comments were submitted to the customer. Four proposed drafts of industry specs (IPC) on flexible PC board materials were reviewed and commented on, these specs are referenced in MIL-P-50884, Flexible Printed Wiring. Proposed spec ANSI/IPS-HM-860, Multi-layer Hybrid Circuits, was reviewed and commented on. A coordination meeting on proposed MIL-P-13949G, Plastic Sheet, Laminated Metal Clad, for Printed Wiring Boards, and a technical meeting on MIL-P-28809 was also attended by Mr. McCormick.

Title ..... : TESTER INDEPENDENT SOFTWARE SUPPORT SYSTEM (TISSS)
CONFERENCE ARRANGEMENTS

IITRI Project Number A06119
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : RADC/RBRP
GRIFFISS AFB, NY. 13441
Technical Representative : AL TAMBURINO

Performance Period ..... : 1 February 1985 to 31 March 1985
Contract Value ..... : $6,250.00

Project Summary

The Tester Independent Software Support System program is a tri-service program to develop a system for the automatic generation of test specification and test programs for MIL-Spec/microelectronics. It was the responsibility of the Reliability Analysis Center to provide administrative services in connection with the TISSS Evaluation and Conference held in Syracuse, New York on February 27, 28 and March 1, 1985.

Support included site selection from various hotels in the Syracuse area. Once the site was selected (The Sheraton Inn) arrangements for the presentation hall, luncheons, coffee breaks, cocktail reception and audio-visual equipment were completed.

The Reliability Analysis Center was responsible for preparing and mailing conference invitations to approximately 600 prospective conference attendees and responding to numerous inquiries regarding the conference.

Upon completion of the conference, the Reliability Analysis Center was responsible for verifying all transactions connected to the conference by the hotel and audio-visuall firm.

Title ..... : PARTS COUNT RELLIABILITY PREDICTION FOR THE AN/SMQ-11

IITRI Project Number ... : A06121
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US NAVY
Address ..... : NAVAL AVIONICS CENTER
INDIANAPOLIS, IN. 46218
Technical Representative : R. BLONDON

Performance Period ..... : 25 February 1985 to 25 April 1985
Contract Value ..... : $19,000.00

Project Summary

The objective of this project for the Naval Avionics Center (NAC), was to perform a parts count reliability prediction on the AN/SMQ-11 Weather Satellite Tracking system using parts lists, schematics, and other applicable information supplied by NAC.

The prediction method employed in this effort evaluated each component (by generic type) for its reliability characteristics - as determined by material and design features, quality practices, and operating conditions - and combined these failure rates in an appropriate manner to formulate an estimate of equipment failure rates.

The work was done in accordance with good engineering practices, the requirements of MIL-HDBK-217D "Reliabililty Prediction of Electronic Equipment" for electronic parts, and the use of the Reliability Analysis Center's publication "Nonelectronic Parts Reliability Data" (NRPD-2) generic failure rates for mechanical and electromechanical parts, as required.

Title ..... : PREPARATION OF MIL-STD-781D & MIL-HDBK-781

IITRI Project Number ... : A06123
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US NAVY
Address ..... : US. NAVY ELECTRONICS COMMAND
Technical Representative : JOHN BROOKS

Performance Period ..... : 12 April 1985 to 12 September 1985
Contract Value ..... : $42,750.00

Project Summary

The purpose of this project, performed for the U.S. Navy Electronics Command (NAVELEX), was to update Military Standard 781D, "Reliability Tests-Exponential," and Military Handbook 781. The effort involved their review and synthesis of the final set of joint government/industry comments from the most recently issued working drafts. In addition, a new revision of MIL-STD-781 was drafted, consisting of a user guide for selecting a reliability test plan.

MIL-STD-781D defines test plans based on the exponential (constant hazard rate) distribution for evaluating reliability of systems/equipments for reliability demonstration and production acceptance. MIL-HDBK-781 is a supporting document which describes the supporting engineering and statistical procedures used in MIL-STD-781D.

The MIL-STD-781D and MIL-HDBK-781 provide the reliability community with a powerful set of tools for realistic reliability testing which will substantially enhance operational readiness.

Title ..... : DEVELOPMENT AND PRESENTATION OF RELIABILITY AND MAINTAINABILITY SEMINARS

IITRI Project Number ... : A06124
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : WARNER ROBINS - ALC
ROBINS AFB, GA.
Technical Representative : PAUL BABCOCK & W. WOODALL

Performance Period ..... : 20 May 1985 to 9 May 1986
Contract Value ..... : $43,000.00

Project Summary

This tutorial evolved from the material found in WRALC document WR-RMTNI-1 (Practical Application of Reliability and Maintainability Training Manual) which RAC had prepared as the result of updating and revising a basic RPHMI training document which WRHLC had prepared in 1982. WRALC asked RAC to prepare a five-module tutorial expanding on the WR-RMTM-1 treatment of the following 5 tasks:

- o FRACAS and Failure Review Board
- o Failure Modes and Effects Criticality Analysis (FMECA)
- o Parts derating
- o Reliability Growth Test
- o Reliability Demonstration

Preparation of the tutorial took place over the period 5/20/85-1/15/86. Presentation of the tutorial took place 5/4-5/9/86. There were approximately 40 attendees and the course was given twice a day with the same material being presented in the AM and PM, for five days.

Title ..... : ELECTRICAL AND MECHNICAL RELIABILITY ANALYSIS FOR THE SM450 MAP FUZE

IITRI Project Number ... : A06128
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY
Address ..... : HARRY DAIMOND LABORATORES
ADELPHI, MD. 80783
Technical Representative : DON HUNTER

Performance Period ..... : 23 May 1985 to 31 October 1985
Contract Value ..... : $40,315.00

Project Summary

The purpose of this effort, performed for the Harry Diamond Laboratories, was to provide reliability support and reliability guidance to the SM450 MAP Fuze program. A three-phase program has been developed to provide the required reliability support.

The first phase consisted of a review and analysis of available fuze documentation (specifications, drawings, parts lists, etc.) and operational and storage environmental profiles.

In the second phase of the reliability prediction, a sensitivity analysis was prepared which provided an objective measure of fuze reliability, the required non-operating failure rate to meet reliability specifications, and the combination of device characteristics required to meet the reliabiliy specification.

A Failure Modes Effects Analysis (FMEA) was performed in the final phase. FMEA is a reliability procedure that investigates possible failure modes in the fuze design. The analysis determined the effect of each possible failure on system operation, and identified single failure points which are critical to mission success.

Title ..... : PARTS COUNT RELIABILITY PREDICTION FOR THE AN/SKQ-9 TELEMETRY DATA RECIEVER/RECORDER SET

IITRI Project Number ... : A06129
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : NAVY
Address ..... : NAVAL AVIONICS CENTER
INDIANAPOILS, IN. 46218
Technical Representative : R. BLONDON

Performance Period ..... : 28 May 1985 to 28 August 1985
Contract Value ..... : $35,300.00

Project Summary

This project was performed for the Naval Avionics Center (NAC). Its objective was to provide a parts count reliability prediction on the AN/SKQ-1 equipment from parts lists, schematics, and other applicable information supplied by NAC.

Component selection in the design stage has a considerable effect on system reliability, since the design characteristics and reliability of a component are factors which follow the system from conceptionto operation. The prediction method to be employed in this effort evaluates each component for its reliability characteristics as determined by material and design features, quality practices, and operating conditions, and combines these failure rates in a manner which formulates as estimate of equipment failure rate. The basic prediction procedures have been standardized for electronic equipment in MIL-HDBK-217D.

The reliability prediction method used in this effort incorporates the same mathematical models used in the MIL-HDBK-217D stress analysis technique. The method identifies components posing potential reliability problems which may be corrected through quality-level upgrades or redesign during the pre-production period.

Failure rates for hardware items not addressed in MIL-HDBK-217A were derived from "Nonelectronic Parts Reliability Data," a professionally accepted RAC publication composed of generic failure rates of mechanical and electromechanial parts.

Title ..... : PREPARATION AND PRESENTATION OF TUTORIAL ON NAC R&M STANDARD MODULE #2

IITRI Project Number ... : A06131
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : NAVAL AVIONICS CENTER
Address ..... : NAC
INDIANAPOLIS, IN. 46218
Technical Representative : R. BLONDON

Performance Period ..... : 18 April 1985 to 31 July 1985
Contract Value ..... : $14,590.00

Project Summary

This effort was performed for the Naval Avionics Center. The objective of this project was the preparation and presentation of tutorials based upon the reliability and maintainability standards and tasks delineated in NAC R&M-STD-R00010 (Reliability Program Requirements Selection). These standards constitute a series of working-level reliability and maintainability documents prepared for use by NAC program managers, and project and design engineers in specific areas of interest.

The Reliability Analysis Center (RAC) prepared a two-hour tutorial on the purposes, requirements, and applications of the process and procedures incorporated in each R&M standard. RAC personnel presented 10 two-hour presentations of this tutorial in a one-month period.

The tutorial was based on the following standards:

- R200.2 - Service Use Profile
- R201 - Reliability Modeling
- R202 - Reliability Allocations
- R203 - Reliability Predictions
- R204 - Failure Modes Effect and Critical Analysis (FMECA)
- R205 - Sneak Circuit analysis
- R206 - Electronic Parts/Circuits Tolerance/Worst-case Analysis
- R208 - Reliability Critical Items
- R210 - Fault Tree analysis

Title ..... : STATISTICAL RAM ANALYSIS FOR MSAAP

IITRI Project Number ... : A06132
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARNY
Address ..... : PICATINNY ARSENAL
DOVER, NJ.
Technical Representative : S. KARLIN

Performance Period ..... : 21 June 1985 to 1 September 1985
Contract Value ..... : $20,000.00

Project Summary

The purpose of this project for the Army AMCCOM at Picatinny, Dover, NJ was to review and evaluate the statistical test methodology invoked during prove-out of Army Ammunition Plants (AAP) for verifying production capacity. The study was specifically defined in relation to the Mississippi Army Ammunition Plant (MSAAP). The specific objective of this project was to verify that testing at a plant rate of 10,000 units per month provides a valid statistical basis for estimating production capability of each operation/subsystem with 90% confidence.

The assessment of the MSAAP productivity test statistical demonstration plan was completed. Results show that the test is valid for implementation at an attained capacity of 10,000 units/month.

Title ..... : ANALYSIS OF INTERMITTENT FAILURES DURING MAINTAINABILITY DEMONSTRATION

IITRI Project Number ... : A06135
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : RADC/RBE
GRIFFISS AFB, NY. 13441
Technical Representative : PRESTON MACDIARMID

Performance Period ..... : 26 June 1985 to 1 October 1985
Contract Value ..... : $40,000.00

Project Summary

This project increased understanding of intermittent failures and enhanced maintainability demonstration procedures.

It was felt that maintainability demonstration procedures do not adequately address intermittent failures, and therefore the full benefits of these demonstrations were not being realized. With the addition of simulated intermittent failures into the maintainability demonstration test, a more accurate method of fault isolation could be achieved. In addition, isolation of intermittent failures should lead to the reduction of such problems in the development of military systems.

A comprehensive data/information collection effort was performed to define the physical causes and determine typical periodicities of intermittent failures in military electronic equipment. Collectively field and test data sources represented more than 3.3 million equipment operating hours and some 3,308 intermittent failures. Acutual causes of intermittent failures could not be statistically determined but through the use of survey information and interviews it was determined that electrical connections and connectors were a major contributor. The data collected and presented in this project could be used to enhance existing maintainability demonstration procedures. However, before such procedures could be enhanced a means to simulate intermittent failures will have to be developed.

Title ..... : RELIABILITY SUPPORT FOR EP/TAB DEVICES

IITRI Project Number ... : A06140
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY
Address ..... : ARDC
PICATINNY ARSENAL, NJ.
Technical Representative : RUTH NICOLAIDES

Performance Period ..... : 29 July 1985 to 30 September 1987
Contract Value ..... : $72,500.00

Project Summary

The Reliability Analysis Center supported the RAM assessment of a Tape Automated Bonding (TAB) process utilized to manufacture hybrid integrated circuits. This technology is being considered for a "smart" munitions application. RAC efforts have included the development of an environmental test program and an industry survey to determine current TAB manufacturers and processes. Interpretation and analysis of this information will assure with some confidence that a reliable product/technology is being designed and acceptable for use in smart munitions.

Title ..... : AUTOMATED TOOLS FOR RAM ASSESSMENT

IITRI Project Number ... : A06141
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY/AMCCOM
Address ..... : AMCCOM
DOVER, NJ. 07081
Technical Representative : JIM BEVELOCK

Performance Period ..... : 18 July 1985 to 1 October 1986
Contract Value ..... : $90,000.00

Project Summary

This study aided U.S. Army AMCCOM in the assessment of needs and identification of tools which will aid the RAM engineer and ultimately lead to improved weapon system operational availability. Initial focus was on artillery weapons systems, although the tools are expected to have more general applicability.

As the state-of-the art in artillery weapons systems advances, and as the battlefield environment becomes more complex, it becomes increasingly difficult to address the myraid Reliability, Availability and Maintainability (RAM) issues with the conventional (typically manual) methods.

This study focused on two specific areas which were not adequately addressed by current RAM technology. These areas were: (1) Determination of system RAM requirements, based on actual battlefield considerations; (2) Study of the Impact of Computer Integrated Manufacturing (CIM) on system reliability engineering.

Other areas which need to be addressed were deferred to later studies.

Title ..... : RELIABILITY STUDY OF ELECTRONIC COMPONENTS AT AAPS

IITRI Project Number ... : A06155
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY
Address ..... : AMCCOM
DOVER NJ
Technical Representative : WILLIAM DOREMUS

Performance Period ..... : 1 November 1985 to 1 November 1986
Contract Value ..... : $79,513.00

Project Summary

The objective of this effort was to evaluate and summarize previously collected reliability data on Electronic Process Control Systems (EPCS) at Army Ammunition Plants (AAPs). Working with data and reports generated during previous reliability studies at AAPs, the tasks included:

- Collection and collation of EPCS bills of materials, reliability predictions, and lessons learned.
- Summarization of the reliability and readiness data.
- Assessment of the ability of the EPCSs to meet Army readiness requirements.

A report was prepared detailing the assessment of the EPCSs to meet the Armys requirements for readiness.

Title ..... : RAM & S/W ANALYSES OF ELECTRONIC PROCESS CONTROL SYSTEM AT HAWTHORNE

IITRI Project Number ... : A06156
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY
Address ..... : AMCCON
DOVER NJ
Technical Representative : WILLIAM DOREMUS

Performance Period ..... : 1 November 1985 to 1 November 1986
Contract Value ..... : $117,000.00

Project Summary

This effort supported the AMCCOM Layaway and Mobilization Plan (LAMP) by identifying problem areas and by recommending solutions associated with selected EPCSs at Hawthorne Army Ammunition Plant (HAAP).

The objective of this effort is to conduct an analysis of the Electronic Process Control Systems (EPSCs) in Area 117 at HAAP. The analysis assessed the functional availability of EPCSs in Area 117 and will provide data for the planning and implementation of a LAMP at HAAP.

The following tasks were performed to accomplish these objectives:

- Performed an on-site review, utilizing checklists developed for previous LAMP efforts.
- Created a top-down block diagram of the EPCS hardware, illustrating the EPCS configurations and identfying the system elements.
- Developed a Bill of Material for each of the EPCSs located in Area 117.
- Created procedures to establish the minimum availability of the basic controllers and implemented procedures to verify the system integrity.

Title ..... : MSAAP RAM STUDY

IITRI Project Number ... : A06160
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY AMCCOM
Address ..... : AMCCOM
DOVER, NJ. 07081
Technical Representative : WILLIAM DOREMUS

Performance Period ..... : 1 January 1985 to 30 September 1987
Contract Value ..... : $725,000.00

Project Summary

The purpose of this effort was to incorporate Reliability, Availability, Maintainability (RAM) and Quality Control (QC) into the Facility Information Control Systems (FICS) at Mississippi Army Ammunition Plant (MSAAP). The following tasks were performed to accomplish this objective:

- Expand the system modeling effort to include RAM and QC into all subsystems functions to MSAAP.
- Add descriptions for the functional elements located in each subsystem.
- Define data elements required in the documentation describing the MSAAP environment.
- Establish an automated approach to be used to create a Bill of Materials for the EPCS at MSAAP.
- Evaluate automated reliability, maintainability and readiness software tools that could be used by the FICS to support RAM and QC requirements at MSAAP.

Title ..... : PRODUCTION READINESS ENHANCEMENT PROGRAM-ELECTRONICS 1986

IITRI Project Number ... : A06161
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY (AMCCOM)
Address ..... : AMCCOM
DOVER, NJ. 07081
Technical Representative : WILLIAM DOREMUS

Performance Period ..... : 1 December 1985 to 1 December 1986
Contract Value ..... : $636,000.00

Project Summary

The purpose of this effort was to refine and expand the "Handbook for the Acquisition of Electronic Process Control Systems for Army Ammunition Plants," written by RAC during a previous effort for AMCCOM.

The objectives were to enhance the existing Handbook based on new standards for reliability, testability, and software, and to expand its scope to include state-of-the-art Computer Integrated Manufacturing (CIM) technology as it is applicable to Electronic Process Control Systems (EPCS) and Factory Information Control Systems (FICS) for Army Ammunition Plants.

The following tasks are required to accomplish these objectives:

- Incorporate into the Handbook updates from MIL-STD-785B and MIL-STD-217D, include MIL-STD-2165, and Adapt DOD-STD-2167.
- Broaden the Handbook concept to incorporate CIM technology.
- Coordinate implementation of the Handbook with PBM engineers for on-going and planned systems.
- Continue and complete the modeling study for trial Handbook implementation already initiated at MSAAP for Materials and Maintenance.
- Analyze and review RAM impact for CIM technology for adaptation to current and future Army plant requirements.

Title ..... : RELIABILITY DEMONSTRATION FOR SYSTEMS WITH REDUNDANCY

IITRI Project Number ... : A06162
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : RADC/RBE
GRIFFISS AFB, NY. 13441
Technical Representative : CHARLES BOUGH

Performance Period ..... : 1 November 1985 to 1 January 1986
Contract Value ..... : $14,500.00

Project Summary

This study researched existing test plans and developed a practical technique for demonstrating the Mean-Time-Between-Critical Failures (MTBCF's) of a system with redundancy in its design. The technique adopted may be used by engineers and engineering managers. The study was conducted with the final user in mind; the technique and report were structured for the nonstatistician.

The robustness of existing test plans in demonstrating MTBCF was assessed by a simulation performed on the HP Series 9000.

Based on a literature search and simulation study, an MTBCF demonstration test plan was recommended in a straightforward users guide. Limmited testing for specific redundant configurations was conducted using the simulation model.

Title ..... : LEAD-FICS: FACILITY INFORMATION CONTROL SYSTEM FOR LETTERKENNY ARMY DEPOT

IITRI Project Number ... : A06169
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY/PBM
Address ..... : PICATINNY ARSENAL
DOVER, NJ. 07081
Technical Representative : R. SCOLA

Performance Period ..... : 24 March 1986 to 30 September 1987
Contract Value ..... : $1,145,000.00

Project Summary

This project was performed for the U.S. Army AMCCOM. The objective of this effort was to scope and plan an overall program to integrate quality, reliability, and maintainability functions into the Letterkenny Evaluation, Analysis and Planning (LEAP) program. Working with Letterkenny and Production Based Mondernization Agency Personnel, the tasks include assistance in:

- o Integration of RAM and QC into the LEAP program
- o Definition of requirements
- o Identification of requisite input parametrers and information
- o Definition of output requirements

The methods of Modern Structured Analysis were applied to produce a functional specification of information processing, storage, and communication requiremenets at LEAD. To optimize the analysis phase, a high-level General Functional Specification was developed first. Information handling functions that are being adequately addressed by existing subsystems or that can be fulfilled by commercially available packages were identified and/or recommended, using the general specification as a guide. Priorities for detailed analysis and modeling were established for remaining areas.

A demonstration project, implementing a system to handle a small portion of the overall information environment, was undertaken as part of this effort.

Title ..... : NAC RAM STANDARDS DEVELOPMENT PROGRAM MODULE #3

IITRI Project Number ... : A06171
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US NAVY
Address ..... : NAVAL AVIONICS CENTER
INDIANAPOLIS IN. 46218
Technical Representative : R. BLONDIN

Performance Period ..... : 19 March 1986 to 19 August 1986
Contract Value ..... : $10,694.00

Project Summary

The purpose of this effort was to prepare a two-hour Tutorial on the purposes, requirements and applications of the processes and procedures incorporated in each R&M standard included in module #3.

There were six two-hour presentations of module #3 made during three successive days. Module #3 consisted of the following R&M standards:

R300.1 - TEMP
R301 - Environmental Stress Screening
R301.1 - System Burn-in/Screening
R301.1 - Module Burn-in
R302 - RDGT Program
R303 - RQT Program
R304 - PRAT Program
R305 - Preproduction Test Program

Title ..... : CORPUS CHRISTI DEPOT PRELIMINARY RAM STUDY

IITRI Project Number ... : A06176
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US ARMY/MPBMA
Address .. .. : PICATINNY ARSENAL
DOVER, NJ. 07801
Technical Representative : R. SCOLA

Performance Period ..... : 1 May 1986 to 30 September 1987
Contract Value ..... : $44,100.00

Project Summary

A study on RAM aspects of engine test cell operations was performed for the U.S. Army Armament, Munitions and Chemical Command (ADCCOM). The purpose of the study was to evaluate quality control (QC) along with Reliability and Maintainability functions of the present engine test cell operations and offer assistance with analysis and design of future engine test cell operations. Assistance provided by RAC to the Production Based Modernization Agency (PBMA) on the Corpus Christi RAM study were:

- An evaluation of engine test cell operations at the Red River and Corpus Christi Army Depots.
- A preliminary analysis of present operations against Depot suggested future needs.
- Recommendations and justification of closed loop test cell control operations to increase test quality and reliability at the Red River and Corpus Christi Army Depots.

A report listing recommendations was submitted by RAC to PBMA for consideration in future test cell modernization. The report addressed RAM aspects for present open loop and future closed loop operations.

Title ..... : R&M SUPPORT FOR SOLID STATE RECEIVER/DIGITAL MOVING TARGET INDICATOR (SSR/DMTI)

IITRI Project Number ... : A06182
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : FAA
Address ..... : 800 INDEPENDENCE AVE S.W.
WASHINGTON DC 20591
Technical Representative : WILLIAM LOWE

Performance Period ..... : 15 January 1986 to 30 September 1986
Contract Value ..... : $12,000.00

Project Summary

The Federal Aviation Administration tasked RAC to provide reliability and maintainability engineering monitoring and support during the design, development and production of the air route surveillance radar solid state receiver/digital moving target indicator modification kit (ARSR, SSR/DMTI Mod Kit). This equipment will replace the vacuum tube front ends of ARSRs 1, 2 and the FPS-20 family of long range radars.

The reliability and engineering support was provided throughout the design, development and production cycle and will consist of analyses, data collection, liaison and consultation, as required. The objective of this effort was to monitor and analyze the contractor's performance in the reliability and maintainability areas and to keep the FAA apprised of this performance as measured against contractual requirements.

Title ..... : HARDWARE/SOFTWARE RELIABILITY PREDICTION HANDBOOK

IITRI Project Number ... : A06186
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : RADC/RBET
GRIFFISS AFB, NY 13441
Technical Representative : E. FIORENTINO

Performance Period ..... : 15 February 1986 to 15 December 1986
Contract Value ..... : $50,000.00

Project Summary

The Reliability Analysis Center was tasked by the Rome Air Development Center (RADC) to draft a DoD handbook for the the prediction and/or estimation of reliability of combined hardware/ software systems. Input for this study drew heavily on work that was previously completed by SAIC and Martin Marietta under contract to RADC.

Specific techniques and methodologies for the prediction/ estimation of software reliability were extracted from the SAIC and Martin Marietta technical reports and will be edited into handbook format. These methodologies were accompanied by procedures for applicability and usage. Procedures were oriented toward SPOs and other users who have need of tools which may be applied throughout the product life cycle, from conceptual design through field usage and maintenance.

Title ..... : MONITOR AND CRITIQUE OF THE RAYTHEON FMECA ON THE ECM POD

IITRI Project Number ... : A06197
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : WR-ALC/MMRCT
ROBINS AFB, GA. 31088-5609
Technical Representative : DAVE WILLIAMS

Performance Period ..... : 30 November 1986 to 30 November 1987
Contract Value ..... : $97,250.00

Project Summary

This effort was performed under contract to Rome Air Development Center for Warner-Robbins Air Logistics Command. The Reliability Analysis Center (RAC) was tasked to attend design reviews and to critique the logic, thoroughness, timeliness and accuracy of the Failure Mode, Effects and Crticality Analysis (FMECA) performed by Raytheon on the AN/ALQ-184 pod.

The RAC prepared an evaluation of Raytheon's approach to the FMECA and reviewed the proposed final FMECA submitted by Raytheon.

Title ..... : RELIABILITY ANALYSIS OF THE SRAM

IITRI Project Number ... : A06199
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : HQ, AFSC
ANDREWS SFB, MD.
Technical Representative : LT COL TURNER

Performance Period ..... : 31 January 1987 to 30 September 1987
Contract Value ..... : $9,400.00

Project Summary

The objective of this effort for the U.S. Air Force was to perform a dormant reliability prediction on the electronic systems of the AMG-69A SRAM air-to-surface missile. These systems include the control guidance electronics, radar, platform, flight control actuator assembly, and the destination preset computer. RAC also examined the effects of periodic testing on the reliability of the AMG-69A.

The work consisted of the following tasks:

- Determine the structure of each major assembly and develop a system hierarchy.
- Determine the components used within each assembly and gather the information used by the prediction models.
- Predict the dormant failure rate and system reliability at the systems, assembly, board and component levels.
- Determine the sensitivity of the AMG-69A to different storage temperatures, environments, and power cycling cycling rates.
- Determine the effects of periodic testing on system reliability.

Title ..... : COMPUTERIZED SHELTER DATA BASE

IITRI Project Number ... : A06203
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US AIR FORCE
Address ..... : RADC/RBES
GRIFFISS AFB, NY. 13441
Technical Representative : JOHN GUBA

Performance Period ..... : 31 January 1987 to 30 September 1987
Contract Value ..... : $45,600.00

Project Summary

The objective of this effort was to develop a database consisting of maintainability information on the FSC 5411 family of shelters. Emhasis was placed on developing a database to include shelter data from the Air Force, Army, Navy and Marine Corp. Each service's data reporting system was examined to determine the type and quantity of shelter data being reported.

Title ..... : PREPARATION AND PRESENTATION OF TUTORIAL ON NAC R&M STANDARDS MODULE #4

IITRI Project Number ... : A06204
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US NAVY
Address ..... : NAVAL AVIONICS CENTER
INDIANAPOLIS, IN
Technical Representative : R. BLONDIN

Performance Period ..... : 31 January 1987 to 30 September 1987
Contract Value ..... : $10,185.00

Project Summary

The objective of this effort was to develop/prepare a tutorial expository on the contents of six standards comprising training Module #4 of the NAC R&M Standards Development program.

The work consisted of preparing a two-hour tutorial on the purposes, requirements and applications of the processes and procedures incorporated in each individual R&M standard included in Module #4. There were six two-hour tutorial presentations of Module #4. The Module #4 standards are:

R101 - Reliability Program Plan
R102 - Monitor/Control of Subcontractors and Suppliers
R103 - Reliability Program Reviews
R104 - Failure Reporting, Analysis, and Correction Action System (FRACAS)
R105 - Failure Review Board
R106 - Field Data Tracking

Title ..... : SPC FOR SELECTED PILOT PRODUCTION AREAS

IITRI Project Number ... : A06216
Contract Number ..... : F30602-84-C-0162
Contracting Agency ..... : US NAVY/ NAC
Address ..... : BRANCH 414, 600E. 21ST STREET
INDIANAPOLIS, IN. 46219
Technical Representative : LEE COY

Performance Period ..... : 15 June 1987 to 30 September 1987
Contract Value ..... : $30,000.00

Project Summary

The objective of this project is to provide success in at least six pilot areas by employing SPC and provide an implementation plan that this Center will use in implementing SPC throughout the Center.

The desired goal of this program is to improve productivity by increasing quality as well as provide objective techyniques based on data to continuously improve all points within a process and identify process variability for improvement of the process of system. This program shall also provide the following desired results:

- o Involve all employees
- o Open communications
- o Provide in-house expertise in QPE and SPC
- o Educate
- o Eliminate barriers
- o Promote team concept across the center
- o Become the way of life
- o Constant attention to process improvements
- o Data based decisions
- o Ownership
- o Structured problem solving
- o Effective participation and team work

This project is continued under Contract F30602-86-C-0228, IITRI Project No. A06239.

Title ..... : MASS SPECTROMETER FMECA

IITRI Project Number ... : A06222
Contract Number ..... : F30602-84-C-0162, & 87-C-0228
Contracting Agency ..... : US ARMY(AMCCOM)
Address .... : AMSMC-QAV-R(A)
ABERDEEN PROVING GROUND,MD.
Technical Representative : JACK LIPP

Performance Period ..... : 1 August 1987 to 1 September 1987
Contract Value ..... : $28,500.00

Project Summary

This is an effort to perform a reliability analysis on the Mobile Mass Spectrometer MM1 produced by Bruker-Franzen Analytick GmbH, Bremen, West Germany, under procurement by the United States Army. The MM1 is to be used by the U.S. Army on the XM87 NbC Reconnaissance System under development by TRW.

The intent of the project is to assist the U.S. Army and Bruker-Franzen Analytik GmbH with improving the Field Reliability of the MM1 Mobile Mass Spectrometer by suggesting design improvements, based on the results of a Failure Modes Effects and Crtitcality Analysis (FMECA) to be performed.

The Reliability Analysis Center will carry out this task first by determining the MM1's electronic and mechanical component stresses and then predicting the failure rate. This will be accomplished using MIL-HDBK-217E for the electrical components. Once the failure rate is determined, a Failure Modes, Effects and Criticality Analysis will be performed. This will identify reliability critical items which may require further attention for reliability improvements.

For the duration of the project, the Reliability Analysis Center will provide the U.S. Army with support in the following areas with respect to the MM1:

- Operational Reliability prediction in accordance with MIL-HDBK-217E for the electronic components.
- Mechanical Reliability Prediction in accordance with NPRD-3, NPS-1, or other Reliability Analysis Center techniques, as required, for the non-electronic components.
- Non-Operational Reliability Prediction in accordance with RADC-TR-85-91.
- Failure Modes, Effects and Criticality Analysis.
- Recommendations for increased reliability.

ATTACHMENT I:

RAC INFORMATION PACKAGE AND
USER AWARENESS LETTER

NEWS RELEASE

MICROCIRCUIT DEVICE RELIABILITY

MDR-21 TREND ANALYSIS DATABOOK
MDR-21A FIELD EXPERIENCE DATABOOK

MDR-21

MDR-21 investigates possible trends developing in microcircuit reliability, trends which appear as integrated circuits incorporate new designs with increased capabilities and decreased dimensions.

This report investigates digital devices of small, medium and large-scale integration, linear, interface and memory components, and very-large-scale integrated circuits. MDR-21 is separated into sections based on these functional distinctions and is further divided by factors believed to influence operational performance. These factors considered "critical" elements which affect reliability include: basic technology (Bipolar and MOS), screen class, application environment, device packaging (materials and construction), part complexity, power dissipation, and operating temperature.

MDR-21A

MDR-21A deals specifically with Field Reliability Experience of microelectronic components. Digital SSI, MSI, LSI, Linear, Memory, Interface and VLSI devices are included. When used alone or in conjunction with MDR-21, "MICROCIRCUIT DEVICE RELIABILITY TREND ANALYSIS," this document provides valuable information in the selection of microcircuit components.

o Volume I contains data on all types of microcircuits, excluding hybrids, and is divided into three (3) primary environmental sections: Airborne, Ground and Naval. Each section is subdivided by component functional type, specific application environment and device functions. The basic guidelines for this publication use the device's complexity as follows and the design geometry for inclusion in the VLSI sections: (1) 500 or more Digital Logic Gates, and/or (2) 7500 or more Transistors, and/or (3) 16K or more bits of memory.

o Volume II, the failure event/analysis portion, contains detailed listings of the failure's causes which were analyzed following a unit failure. This analysis contains information regarding the device characteristics, environmental conditions at the time of the reported failure, and the exact nature of the failure, which has been categorized as follows: Failure Indicator, Failure Mode, Failure Activating Stress, Failure Defect, and Failure Defect Cause.

Under a cost-recovery directive from the U.S. Department of Defense, we offer these publications for the following prepaid costs:

MDR-21	**$95 per copy in the U.S., ($105 non-U.S.)**
MDR-21A	**$125 per copy in the U.S., ($135 non-U.S.)**
MDR-21 + 21A	**(Set) $200 in the U.S., ($215 non-U.S.)**

Order from and make check payable to Reliability Analysis Center, RADC/RAC, Griffiss AFB, NY 13441-5700.

Reliability & Maintainability Services

RAC

Reliability Analysis Center

RAC RAC

Reliability and Maintainability Services

The RAC provides specialized R&M services, techniques and resources applicable to a wide range of reliability problems and issues. Through nearly 20 years of operating the RAC we have developed a vast expertise and an orientation towards practical reliability services. RAC's objective through the 1990s is to continue advances in reliability technology commitments with advances in product and engineering technologies.

Our highly qualified staff hold a wide diversity of advanced degrees to Ph.D. level, many have formally studied reliability.

Our services include the following expertise areas:

- **Reliability management--designing and managing a reliability department or program**
- **Special studies--research studies into specialized reliability issues. Past studies have included hermetic vs. plastic ICs, confidence bounds for system reliability, ESD materials**
- **Design reliability--techniques for influencing reliability at the design stage including:**
  - **Reliability prediction**
  - **Failure mode and effects/criticality analysis (FMEA) for electronics and mechanical system**
  - **Mechanical reliability**
  - **Plant /process reliability and availability**
  - **Dormant (nonoperating) reliability**
  - **Parts selection/control**
- **Reliability growth--modeling, planning and tracking**
- **Environmental testing/environmental stress screening**
- **Reliability demonstration and life testing and analysis-design implementation**
- **Reliability statistics**
- **Statistical process control as applied to R&M for military systems**
- **Reliability data analysis**
- **Reliability applications software**
- **Failure reporting and corrective action systems (FRACAS)**
  - **Reliability centered maintenance (RCM)**
  - **Maintainability**
  - **R&M specifications and standards**
  - **Electrostatic discharge**

RAC RAC

Full Service Participation Plan

In order to utilize the range of RAC services the Reliability Analysis Center offers a Full Service Participation Plan which affords full access at all times to the vast RAC reliability resources by payment of a single annual participation fee.

The Plan is open to all U.S. Government agencies, government contractors, commercial producers and users, device vendors, laboratories, educational institution and qualified foreign organizations.

Services provided under this plan include:

- **Reliability and Maintainability Engineering and Statistical Consulting**
- **Bibliographical/Literature Searches (Computerized)**
- **EOS/ESD Consulting**
- **RAC Publications**
- **Database Searches**

Participants automatically receive:

- **Reliability Publications--one copy of each publication as they are issued**
- **Discount Privilege--additional copies of any RAC publications (except video tapes) at 20% off list to all employees of a single corporate entity at a single plant location**
- **Access to RAC Resources--without the delay and expense of issuing individual purchase requests (limited only by the balance in user's RAC account)**
- **Account Maintenance--RAC will maintain the account record of funds expended and furnish an account statement every 6 months or at the customer's request**

A RAC Full Service Participation Plan can be opened in two ways:

- **Pre-deposit of a minimum amount of $500.00 U.S., $575.00 non-U.S., the maximum to be determined by the requestor**
- **A purchase order (not less than $500.00 U.S., $575.00 non-U.S.) with a "not-to-exceed" amount indicated (RAC will bill quarterly)**

A subscription can be cancelled by RAC if the account balance remains $35.00 or less for three consecutive months, or at the customer's request.

Address your correspondence to: Charles A. Cox, Jr., User Awareness Manager, Reliability Analysis Center, RADC/RAC, Griffiss AFB, NY 13441-5700. Telephone: 315-337-0900 or Autovon 587-4151.

RAC RAC

Training Courses

The RAC offers professional intensive training courses and seminars. Courses are typically presented four times per year open to the public throughout the country. In-house presentations are also offered at the customer's facility. The standard courses can readily be modified for specific customer needs. RAC recognizes the need for professional lecturing and accordingly retains experts in reliability with extensive teaching experience. We have taught over 250 courses to more than 8500 attendees since 1976. All courses include extensive examples and case histories.

Courses offered are:

- **Design for Testability**
- **Design Reliability**
- **Worst Case Analysis**
- **Practical Statistical Analysis with Reliability Applications**
- **ESD Awareness**

Publications

The RAC generates publications covering a wide range of reliability and maintainability topics.

- **Microcircuit Device Reliability**
- **Electronic Equipment R&M**
- **State-of-the Art Reports**
- **Reliability Design**
- **Technical Reliability Studies**
- **Nonelectronic Publications Series**
- **Nonelectronic Parts Reliability**

Individual titles within each series are described in the RAC Information Package.

Software Products

The RAC offers selective reliability software designed for use with IBM or IBM compatible personal computers.

- **Data compilations on floppy disk medium with database management facility and query options**

RAC RAC

Introduction

The Reliability Analysis Center (RAC) is a Department of Defense Information Analysis Center operated under contract by the IIT Research Institute's Rome, NY, Technology Center in affiliation with the Defense Technical Information Center. Its mission is to

- **Provide a central reliability and maintainability (R&M) resource including data, knowledge, literature and techniques**
- **Provide R&M data and services to DoD and DoD contractors**

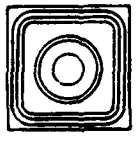
The RAC data resources include databases for:

- **Microcircuits**
- **Discrete Semiconductors**
- **Hybrids**
- **Electrostatic Susceptibility**
- **Systems**
- **Nonelectronics**
- **Reliability Centered Maintenance**
- **Nonoperating**

Each database includes billions of part hours of testing and field operation, retaining reliability data with respect to characteristics such as failure modes, package, technology, construction, environment, quality, and so on. The data are collected from extensive military and commercial sources. The databases reside on an HP 9000 system.

These data are made available to users through publications giving data compilations and through customized computer sources.

Address your correspondence to:



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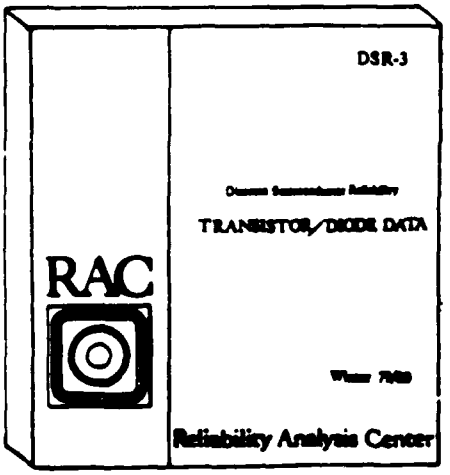
TRANSISTOR/DIODE DATA (DSR-3)

This compilation of reliability data on discrete semiconductors contains information valuable in device selection, failure rate prediction, test specification, screening and corrective action decisions. Detailed and summarized failure rate data derived from field observations and environmental testing describe a wide range of devices used in a variety of electronic systems. 1979, 1980, 420 pages.



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MRAP/SRAP

MICROCIRCUIT/SEMICONDUCTOR RELIABILITY ASSESSMENT PROGRAM (MRAP/SRAP)

MRAP/SRAP provides the electronics community current information on MIL-M-38510 and MIL-S-19500 specification (slash sheet) activity on microcircuit and semiconductor devices. MRAP/SRAP listings provide MIL slash sheet number, generic or vendor part number, device family and function, manufacturing technology and gate, bit or transistor counts. The information is derived from DESC specification status information and is published in loose-leaf form quarterly. Users remain current by replacing each previous quarter's material with the current quarter's material eliminating the need to replace individual sheets. Participation is open to all U.S. Government agencies, government contractors, commercial producers and users, device vendors, laboratories, educational institutions, and qualified foreign organizations. The plan extends for one year, with multi-year plans negotiable. The fee is $125 per year, domestic, and $215 per year, non-U.S. (The non-U.S. fee includes air mail shipment four times per year.) To begin this service, mail your check payable to IITRI/RAC.

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NEW-NEW-NEW

ESD CONTROL IN THE MANUFACTURING ENVIRONMENT (SOAR-6)

RAC is proud to present our latest State-of-the-Art Report publication (SOAR-6).

This document supersedes SOAR-1 (ESD Protective Material and Equipment: A Critical Review). SOAR-6 addresses the establishment of an adequate, cost-effective ESD-control program for the manufacturing environment. An "ideal" ESD control program is developed to provide adequate protection for critical, high-intrinsic-value electronic parts and equipments. This program can be tailored to address specific environments and products based on susceptibility, manufacturing environment, and intrinsic value of the product. SOAR-6 defines specific product qualification and acceptance tests for various ESD protective materials and an effective ESD control program monitoring plan.

1986, 224 pages.

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APPENDICES

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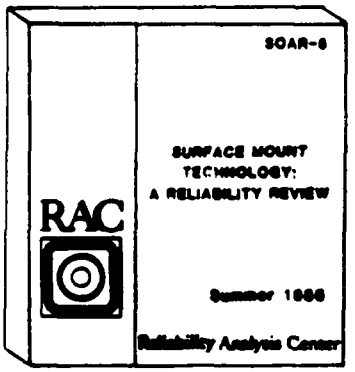
STATE-OF-THE-ART-REPORTS

SURFACE MOUNT TECHNOLOGY: A RELIABILITY REVIEW (SOAR-5)

This document examines the status of surface mounting in the scope of today's manufacturing environment. The objective is to establish the character of surface mount technology (SMT) with regard to its reliability. The document contains investigations of SMT's impact on the manufacturer/user community both in terms of resources and cost.

The primary focus of the report is associated with the specific failure mechanisms of surface mount packages, solder joint connections and printed wiring boards. Evaluating each of these primary areas provides the basis for failure rate model development. While most of the material presented is universally applicable to different device types and package styles, the emphasis is on surface mount packaging and reliability.



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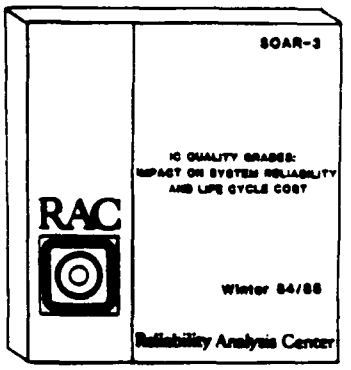
IC QUALITY GRADES: IMPACT ON SYSTEM RELIABILITY AND LIFE CYCLE COST (SOAR-3)

SOAR-3 focuses on the relative reliability, applicability and cost of plastic commercial, hermetic commercial and JAN-qualified integrated circuits. Comparisons of initial costs and procurement lead times are supplemented with discussions on:

- the effects of application stresses
- efficient procurement practices
- life cycle cost analyses

The document ultimately provides objective part selection alternatives for implementing screened and unscreened integrated circuits into electronic systems.



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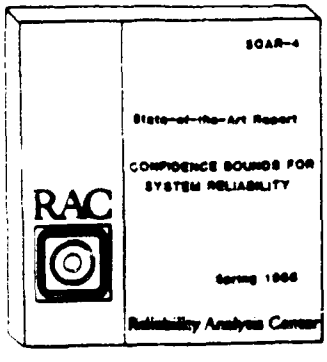
STATE-OF-THE-ART REPORTS

CONFIDENCE BOUNDS FOR SYSTEM RELIABILITY (SOAR-4)

This study supplies algorithms for estimating confidence bounds on system reliability from subsystem reliabililty estimates. Four theoretical methods are compared through a simulation study: these methods are suitable for use in conjunction with subsystem-level fixed sample reliability tests (as described in MIL-STD-781, "Reliability Tests and Exponentia Distribution"). Standard procedure for estin ting and simulating confidence bounds removes the ambiguity often faced by project offices and allows maintenance units to effectively plan support needs. This text is oriented toward non-statisticians. 1985, 200 pages.



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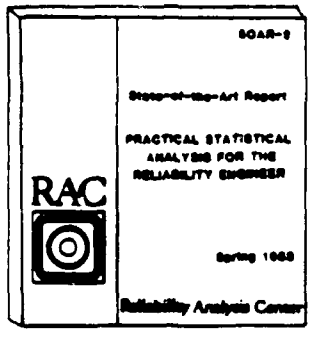
PRACTICAL STATISTICAL ANALYSIS FOR THE RELIABILITY ENGINEER (SOAR-2)

This document consists of a series of "stand-alone" chapters which comprise an elementary text on statistical methods applicable to reliability studies and data analysis. Aimed at the non-specialist, the text explains a variety of statistical methods and covers both parametric and non-parametric methods. Practicing reliability engineers are also aided in selecting and using appropriate analytical methods. SOAR-2 is written in understandable language with a minimum of esoteric mathematics. Graphs, tables and clear, explanatory prose strip away statistical mystique. 1983, 180 pages.



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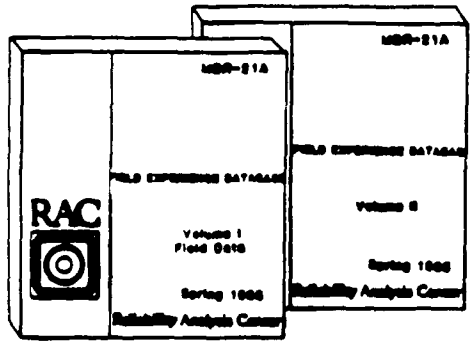
MICROCIRCUIT DEVICE RELIABILITY DATA BOOKS

FIELD EXPERIENCE DATA BOOK (MDR-21A)

This document deals with field reliability experience of integrated circuits including digital SSI, MSI, LSI, linear, memory, interface, and VLSI. Used in conjunction with MDR-21, this two-volume data book provides valuable information for selection of microcircuit components. Volume I contains microcircuit data (excluding hybrids) divided into Airborne, Ground and Naval environments, each of which is subdivided by component functional type, specific application environment and device function. Volume II contains detailed listings of failure causes accompanied by analyses which identify specific device characteristics, environmental conditions and the exact nature of the failure. Data are also available on a floppy disk medium (see RAC products for computers). 1985, 700 pages (two volumes).



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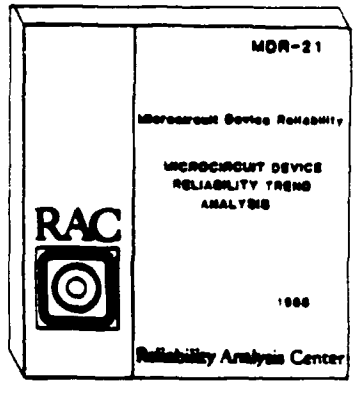
VOL. 1

VOL. 2

TREND ANALYSIS DATA BOOK (MDR-21)

This is a study of microcircuit field failure data with a focus on reliability trends. A Bayesian statistical technique is used to estimate the failure rates of various microcircuit types including: digital SSI, MSI, LSI, linear, interface, memory and VLSI. Failure distribution data describing specific failure mechanisms are presented in a quantifiable assembly of descriptive failure-related terms. Equipment-level comparisons are also given to assess the reliability impact of variations in manufacturers' requirements. The text is complete with graphical presentations and narratives in support of the study findings. 1985, 370 pages.



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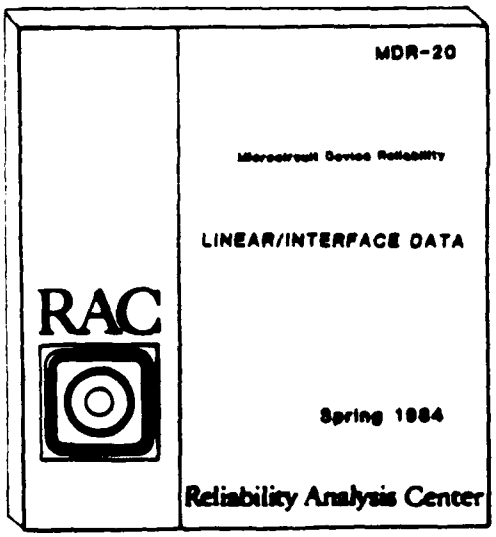
MICROCIRCUIT DEVICE RELIABILITY DATA BOOKS

LINEAR/INTERFACE DATA (MDR-20)

This data book contains relative distributions of factors commonly contributing to linear and interface device failures. The data are grouped according to five major failure descriptor categories: defect indicator, failure mode, failure defect, failure defect cause and failure activating stress. This information is often very useful in performing FMECAs, often used for evaluating system designs. Field failure rate versus MIL-HDBK-217D predictions data is included. 1984, 270 pages.



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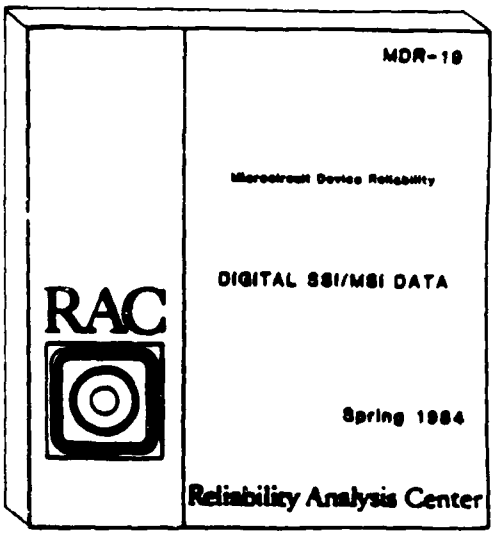
DIGITAL SSI/MSI DATA (MDR-19)

This document lends support to the determination of device fall-out rates through the examination of operational test and field reliability characteristics for digital SSI/MSI devices. Package type, logic family, complexity, temperature, environment and screen class are all examined for their effect in failure rate. The data has been summarized by both life test and field sources as well as by technology. This format allows the user to choose an appropriate combination of source and technology when performing an FMECA. 1984, 418 pages.



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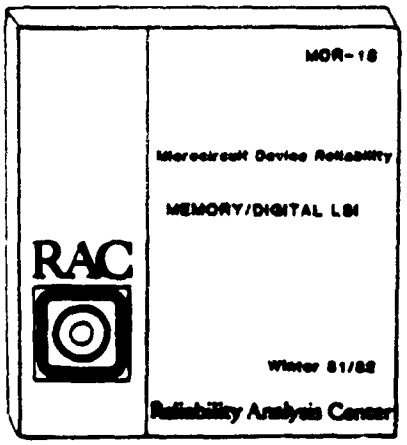
MICROCIRCUIT DEVICE RELIABILITY DATA BOOKS

MEMORY/DIGITAL LSI DATA (MDR-18)

This compilation of memory and digital LSI microcircuit reliability information is derived from environmental stress screening and life test data. The information is specifically used to evaluate the following:

- o device physical properties
- o device failure rates
- o device failure modes and mechanisms

This report will be of optimum use in device selection, failure rate prediction, screening test specification and corrective action decisions. 1981/82, 410 pages.



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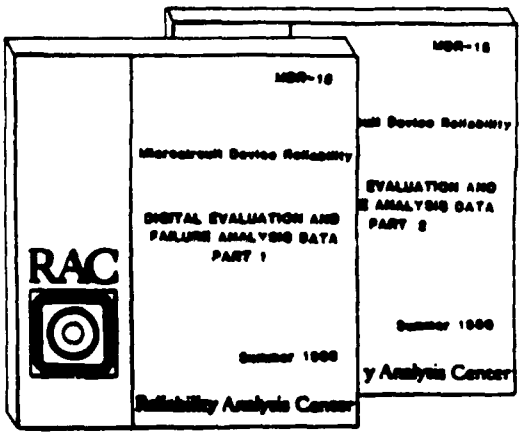
DIGITAL EVALUATION AND FAILURE ANALYSIS DATA (MDR-15)

This two-volume data book can be used as an effective tool in part selection, cost-effective screening program determination, of prevalent failure mechanism identification and failure rate prediction. Volume 1 contains detailed listings of burn-in and environmental/screening test data. Volume 2 contains summarized and detailed digital SSI/MSI data plus failure event information. The failure information comes from device screening programs, equipment-level testing and field operation. 1980, 732 pages (two volumes).



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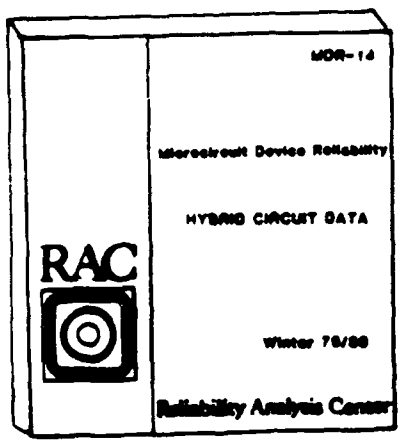
MICROCIRCUIT DEVICE RELIABILITY DATA BOOKS

HYBRID CIRCUIT DATA (MDR-14)

This document highlights over 300 hybrid device types contributed from dozens of government and industry programs. The reliability data is derived from:

- field observations
- reliability demonstration testing
- burn-in/screening tests

Specific device technologies represented in the data are TTL, CMOS and P/N-Channel Field Effect Transistors (FETs). This book is helpful in component selection, failure rate prediction, screening and other associated reliability activities. 1980, 295 pages.



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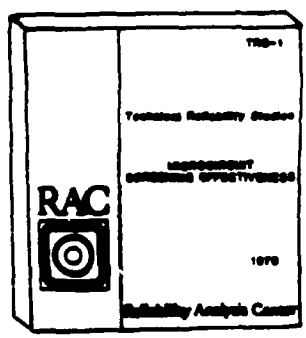
MICROCIRCUIT SCREENING EFFECTIVENESS (TRS-1)

This document is designed to increase user-awareness of factors effecting microcircuit reliability through the application of screening techniques. This report covers MOS and bipolar devices comprised of SSI, MSI and LSI complexities and packaged in plastic or hermetic enclosures. The information is first used to determine efficiency factors of individual screens and tests and then it is combined with cost information for determining screening effectiveness. A mathematical model is expressly formulated for the evaluation of screening cost effectiveness. 1978, 100 pages.



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EOS/ESD PUBLICATIONS

ELECTRICAL OVERSTRESS/ELECTROSTATIC DISCHARGE SYMPOSIUM PROCEEDINGS (1979-1986)

Each volume of the Proceedings contains the most current information and research in the field of EOS/ESD. Each volume emphasizes a variety of topics (different each year).

EOS-8: 1986 PROCEEDINGS
27 PAPERS

- Manufacturing Issues and Ionization
- Latency and Simulation
- Material Test and Evaluation
- Protection Network Design and Evaluation
- EOS/ESD Test Methods and Results

EOS-7: 1985 PROCEEDINGS
28 PAPERS

- Factory Control Issues
- ESD Protection Devices
- Device Failure and Stress Modeling
- Evaluating Materials, Circuit Boards and Taping Operations
- Testing and Failure Analysis

EOS-6: 1984 PROCEEDINGS
27 PAPERS

- Factory and Field ESD Issues
- Ionization and Material Characterization
- Protective Product/Material Evaluation
- ESD Testing and Simulation
- Device Evaluation and Protection

EOS-5: 1983 PROCEEDINGS
28 PAPERS

- ESD Factory and Field Programs
- Testing and Simulation
- Ionization and Materials
- Device Failure Response and Analysis
- Integrated Circuits Protection and Latent Failure Modes

EOS-4: 1982 PROCEEDINGS
29 PAPERS

- ESD at the Device Level
- Failure Modeling and Analysis
- Equipment Level Considerations
- ESD Protective Material Characteristics
- Implementing ESD Procedures and Controls

EOS-3: 1981 PROCEEDINGS
35 PAPERS

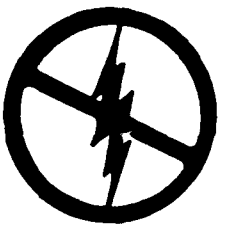
- ESD in the Factory: Event Controls, Practices and Results
- Evaluations of Protective Materials
- ESD Device Protection/ESD Device Evaluation
- Modeling and Analysis
- Effects of Passive Components
- Modeling and Evaluation

EOS-2: 1980 PROCEEDINGS
32 PAPERS

- Electrostatic Discharge: Problems and Techniques
- Protective Devices: Part Failure
- Protective Networks
- Failure Mechanisms and Modeling
- Lightning/EMP
- Implementing EOS/ESD Control

EOS-1: 1979 PROCEEDINGS
29 PAPERS

- Precautionary Measures
- Testing
- Failure Mechanisms
- Electrical Overstress
- Design and Analysis



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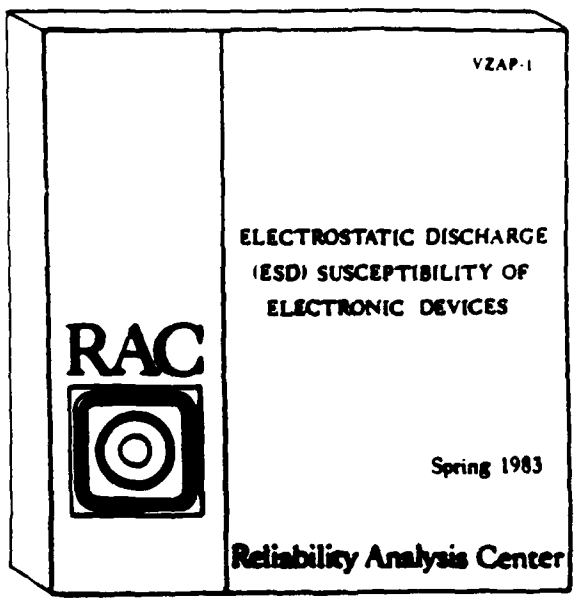
EOS/ESD PUBLICATIONS

ELECTROSTATIC DISCHARGE SUSCEPTIBILITY DATA (VZAP-1)

This data publication contains electrostatic discharge (ESD) susceptibility test and classification data on microcircuits and discrete components. The information is designed to assist in the following:

- selection of least-susceptible com-ponents
- identification of potential areas requiring protective circuitry
- establishment of possible circuit design or function trade-offs
- provide cost/performance versus susceptibility alternatives

Several MIL-STDs, DOS-STDs and DOD-HDBKs are investigated for their classification requirement applicability. Abstracts of references are included. 1983, 341 pages.



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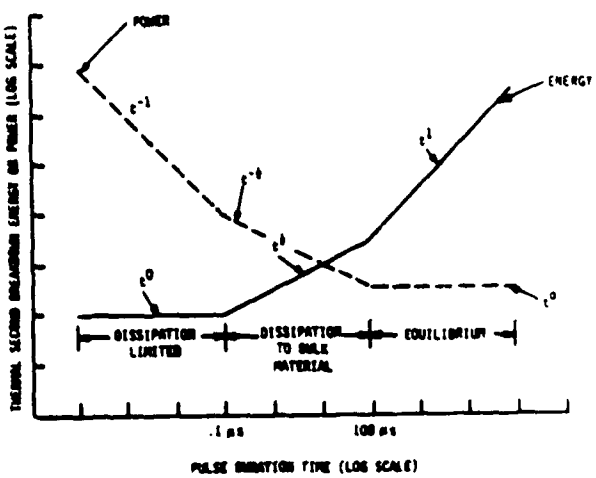

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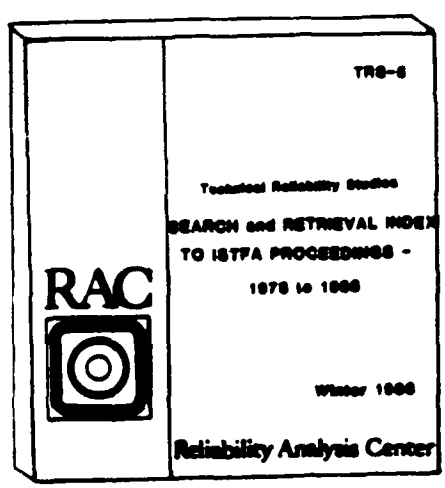
SEARCH AND RETRIEVAL INDEXES

SEARCH AND RETRIEVAL INDEX TO ISTFA PROCEEDINGS 1978-1985 (TRS-5)

This publication makes information retrieval from the International Symposium for Testing and Failure Analysis (ISTFA) Proceedings an efficient procedure. Information is included on every article printed in the eight-year span of ISTFA Proceedings, and that information is separated into six different retrieval categories: abstracts, alphabetical listing of index terms, author, chronological list of papers, corporation, keywords in title, and subject. 1986, pages 377.



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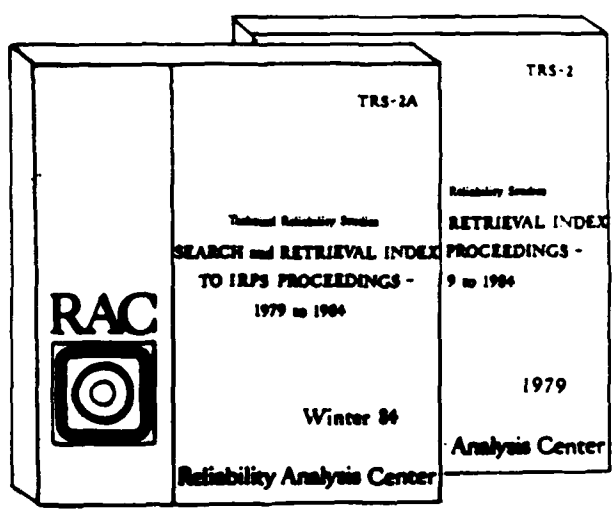
SEARCH AND RETRIEVAL INDEX TO IRPS PROCEEDINGS 1979 TO 1984 (TRS-2A) 1968 TO 1978 (TRS-2)

These volumes provide rapid location of papers on various topics published in IRPS Symposium Proceedings. The papers encompass the most up-to-date work performed to enhance our understanding of electronic device physics of failure. Four types of indexes are employed including: authors, corporations, subjects, and index terms. Within the chronological listing of all papers the detailed index terms provide an overview of the intent and depth of each paper. TRS-2A 1984, 210 pages, TRS-2 1979, 385 pages.



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(TRS-2A)

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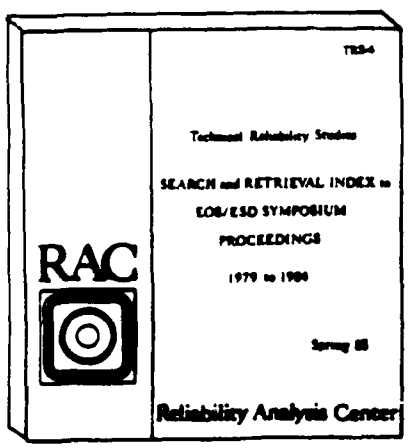
SEARCH AND RETRIEVAL INDEXES

SEARCH AND RETRIEVAL INDEX TO EOS/ESD PROCEEDINGS, 1979-1984 (TRS-4)

This document provides quick access to articles published in the annual EOS/ESD Symposia from 1979 to 1984. Papers published in the Proceedings represent the most current studies and information available on the effects of EOS/ESD phenomena on electronic devices. Indexes include an alphabetical listing of terms, subjects, authors, corporations, keywords in the title and a chronological list of papers. 1985, 133 pages.



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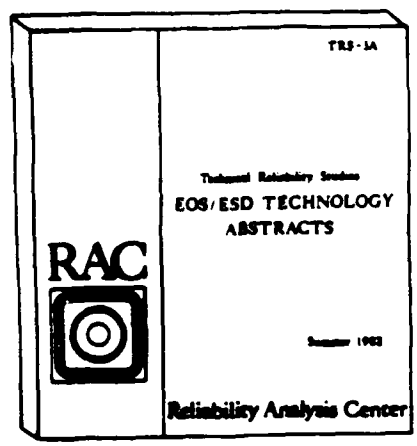
EOS/ESD TECHNOLOGY ABSTRACTS, 1982 (TRS-3A)

This document provides a comprehensive bibliography of literature pertaining to electrical overstress and electrostatic discharge damage. Reference to the degradation of electronic devices encompasses design, failure analysis, protective measures/techniques and training programs. The references were selected from the Reliability Analysis Center's document files which include acquisitions made from 1967 to 1982. Documents were selected for currency, usefulness and availability. 1982, 287 pages.



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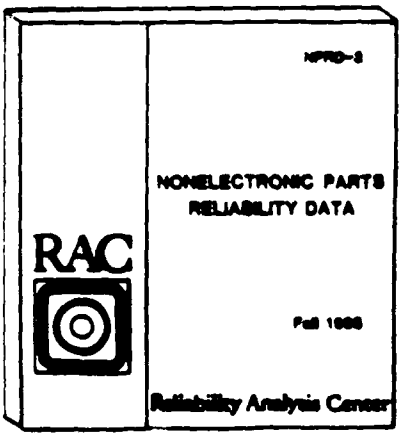
NONELECTRONIC RELIABILITY PUBLICATIONS

NONELECTRONIC PARTS RELIABILITY DATA (NPRD-3)

This compilation of nonelectronic parts reliability data contains failure rate and failure mode information on a variety of mechanical, electro-mechanical, pneumatic, hydraulic and rotating parts. Component MTBFs for devices which have experienced at least one field failure are presented with detailed failure rates for selected part types in various application environments. The failure rate information covers many devices for which no MIL-HDBK-217 reliability prediction models exist.

NPRD-3 data are also available on a floppy disk medium (see RAC products for computers). 1985, 357 pages.



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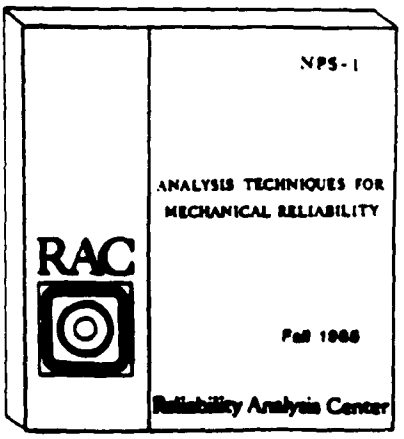
ANALYSIS TECHNIQUES IN MECHANICAL RELIABILITY (NPS-1)

NPS-1 begins a series of documents which are dedicated to mechanical reliability. This document is designed to provide a basic understanding of the fundamental principles of reliability theory by:

- establishing a familiarity with mechanical reliability terminology
- examining modern analysis techniques
- providing extensive examples and references to enhance further study

Specifically included are failure mode evaluation techniques (FMECA and FTA), design analysis techniques and quantitative performance estimation techniques directly applicable to mechanical designs. 1985, 176 pages.



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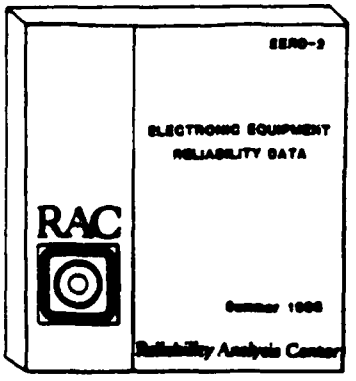
EQUIPMENT DATA PUBLICATIONS

ELECTRONIC EQUIPMENT RELIABILITY DATA (EERD-2)

This publication evaluates system/equipment level reliability. The compendium contains data on military electronic equipments at the set, group and unit levels derived from the RAC's dedicated data base. This data base contains specific information on the contractual and technical descriptions of equipment reliability, availability and maintainability. The primary objective of the document is to provide sufficient information for the evaluation of common reliability practices as well as for the investigation of those parameters designed to assist in the development of reliable equipments. Further, the data helps to refine, revise and develop reliability and maintainability prediction, allocation and demonstration techniques with regard to the environment and type of equipment. 1986, 400 pages.



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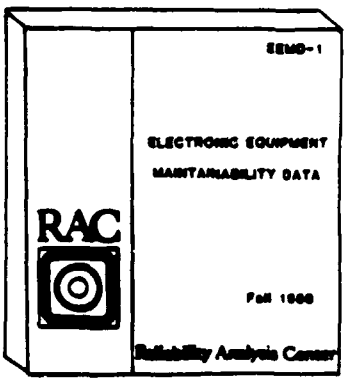
ELECTRONIC EQUIPMENT MAINTAINABILITY DATA (EEMD-1)

This compendium contains maintenance and repair time data on military electronic equipments at the subsystem, set, group and unit levels. The document presents a variety of detailed equipment level maintainability data to assist in the effective evaluation of equipment field reliability. The information is given to facilitate the tracking of an equipments maintainability characteristics throughout its life cycle as well as to provide a baseline for comparison between similar equipments. 1980, 310 pages.



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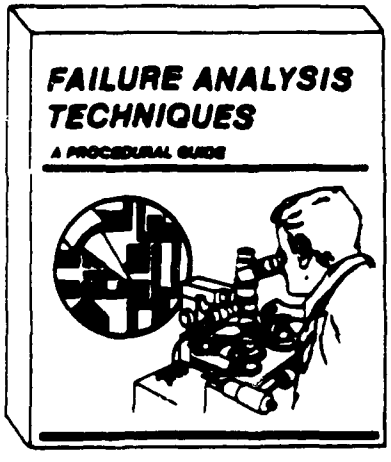
GUIDES/HANDBOOKS

MICROCIRCUIT FAILURE ANALYSIS TECHNIQUES PROCEDURAL GUIDE (MFAT-1)

This volume represents a collection of the most used failure analysis techniques and serves as a useful tool and reference source for failure analysts at all levels of experience. Each major failure analysis technique is discussed with examples or suggestions for its use in performing failure analysis on semiconductor devices. Approximate costs for major equipment needed to perform each technique are provided with numerous references to assist in further research. 1981, 982 pages.



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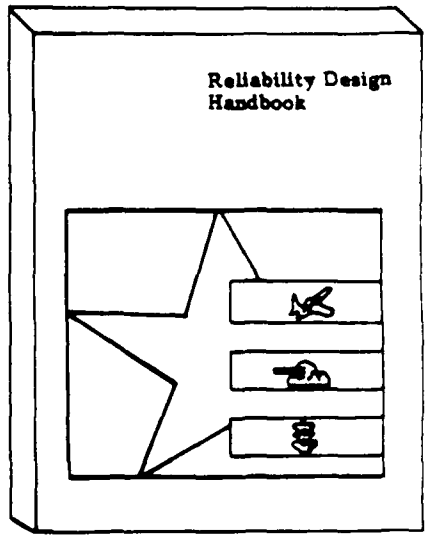
RELIABILITY DESIGN HANDBOOK (RDH-376)

Intended as a tool for designers of military equipment, the document provides design information factors, guidelines and other engineering parameters affecting reliability. RDH-376 concentrates on the approach to reliable design, including theoretical design and cost considerations. Methods applicable to those considerations, such as part control, derating, environmental resistance, redundancy, and design evaluation are all thoroughly explored in the document. 1976, 400 pages.



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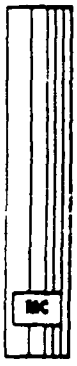
RAC PRODUCTS FOR PERSONAL COMPUTERS

NONOPERATING RELIABILITY PREDICTION SYSTEM (RAC-NRPS)

This comprehensive software system predicts the impact of nonoperating periods on equipment reliability. The results of this analysis will be extremely useful when the target system is subjected to extensive storage periods and relatively short operating times. In this situation, the disparity in the two time periods will cause the majority of the failures to occur during the nonoperating period, regardless of the fact that the operating failure rate is generally much higher. It is intended that this analysis will complement a prediction of operating reliability. All models used in the prediction are bsed on research described in RADC-TR-85-91, "Impact of Nonoperating Periods on Equipment Reliability." 1986, 1 floppy disk.



Nonoperating Reliability Prediction System

RAC - NRPS

David J. Dekkers

Fall, 1986

Reliability Analysis Center

Griffiss Air Force Base, New York 13441-5700
Phone (315) 330-4151 Autovon 587-4151

A DoD Information Analysis Center

Computer Requirements

- IBM Personal Computer - PC, XT, AT or compatibles
- 10 MB Hard Disk Drive or Two Floppy Drives
- 384K Available Memory
- IBM Compatible Printer
- Any Monitor and Video Card

Features

- Levels of assembly include system, subsystem, set, group, unit, assembly, subassembly and part as defined in MIL-STD-280-A, with a maximum of 90 levels of assembly allowed.
- Models used are a complete implementation of RADC-TR-85-91, with part classifications complementary to MIL-HDBK-217.
- Parts can be associated with any level of assembly.
- Includes a specialized statistical model to analyze the effects of test and repair actions on system reliability.
- Features a single keystroke menu system, a complete set of data input and editing functions, on-screen help features and extensive data quality checking.
- A global change menu allows environment, power test cycles, ambient temperature and assembly names to be altered for the entire system, or for specific assemblies (if the system is distributed in several storage locations with different characteristics).
- A comprehensive set of reports may be reproduced on any printer. All reports can be generated for an entire system or a particular assembly.
- The software can be customized for a particular customer or application. This requires an additional fee which will be negotiated on a case-by-case basis.
- David W. Coit and Mary G. Priore, authors of RADC-TR-85-91, are currently employed by the Reliability Analysis Center and are available to answer any technical questions concerning nonoperating reliability.

The $1400 purchase price includes the software, support from the RAC engineering staff, updates and the Nonoperating data book. To request a Demonstration Version of RAC-NRPS please contact Charles Cox at the RAC.

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RAC PRODUCTS FOR PERSONAL COMPUTERS

FNPRD-3/FMDR-21A

The Reliability Analysis Center is currently providing two of its most popular data books on floppy disk media. The Nonelectronic Parts Reliability Data Book and the Microcircuit Field Experience Data Book are currently available for IBM PC, XT, AT and compatible computers. These electronic data books conduct rapid searches on numerous data fields and allows the results of these custom searches to be displayed or printed. FNPRD-3 contains failure rate, failure mode and MTBF information on a variety of electro-mechanical components for which no MIL-HDBK-217D, Notice 1 models exist. FMDR-21A provides the user with field experience history on Digital, Linear, Interface, Memory, LSI and VLSI devices.

Microcircuit Device Reliability Data
Field Experience Data Base

FMDR-21A

Michael J. Rossi

Summer, 1986

The Reliability Analysis Center

Griffiss Air Force Base, New York 13441-5700
Phone (315) 330-4151 Autovon 587-4151

A DoD Information Analysis Center

Computer Requirements

- IBM Personal Computer - PC, XT, AT or compatibles
- 256K Available Memory
- IBM Compatible Printer
- Hard Disk Drive (recommended) or Two Floppy Drives
- Monochrome or Color Monitor

Features

- All data files are in dBase III format. A compiled query program is provided to allow simple data searches to be performed and to allow the results of a data search to be displayed or printed.
- Users of Ashton-Tate's dBase III may write their own data access program and report forms.
- The provided query program is menu driven and user friendly.
- The software is not copy protected so therefore can be easily installed onto a hard disk and backed-up using basic DOS utilities.

FNPRD-3
(1986, 3 Floppy Disks)

- Reports produced are identical to those contained in the hard copy volume of NPRD-3.
- Searches are performed by entering the part type and/or the application environment of interest.

FMDR-21A
(1986, 3 Floppy Disks)

- Searches can be performed by device function, part number, manufacturer and application environment.
- The results of a data search may be down loaded to an ASCII text file which can be read by numerous other software packages.

Each volume is contained on a three disk set with its own users manual. For further information regarding each of these programs please contact Michal J. Rossi at the letterhead address.

SERVICE FEE SCHEDULE AND ORDERING INFORMATION
January 1987

Qty.			Price Per Copy Domestic	Foreign
		Component Reliability Databooks		
( )	MDR-14	Hybrid Circuit Data-1980	$60.00	$70.00*
( )	MDR-15	Digital Evaluation and Generic Failure Analysis Data - Vols. I and II-1980	60.00	70.00**
( )	MDR-18	Memory/LSI Data-1982	60.00	70.00**
( )	MDR-19	Digital SSI/MSI Data-1984	60.00	70.00**
( )	MDR-20	Linear/Interface Data-1984	60.00	70.00**
( )	DSR-3	Transistor/Diode Data-1980	60.00	70.00**
		Complete Set: $310 ($360 non-U.S.)***		
( )	NPRD-3	Nonelectronic Parts Reliability Data-1985 (Printed Copy)	80.00	90.00*
( )	VZAP-1	Electrostatic Discharge Susceptibility Data-1983	95.00	105.00**
( )	MDR-21	Trend Analysis Databook-1985 (Printed Copy)	95.00	105.00**
( )	MDR-21A	Field Experience Databook-1985 (Printed Copy)	125.00	135.00**
		Set: $200 ($220 non-U.S.)***		
( )	NONOP-1	Nonoperating Reliability Data-1986	150.00	160.00**
		Equipment Databooks		
( )	EERD-2	Electronic Equipment Reliability Data-1986	80.00	90.00**
( )	EEMD-1	Electronic Equipment Maintainability Data-1980	60.00	70.00*
		Handbooks		
( )	RDH-376	Reliability Design Handbook-1976	36.00	46.00**
( )	MFAT-1	Microelectronics Failure Analysis Techniques Procedural Guide-1981	125.00	135.00***
( )	NPS-1	Analysis Techniques For Mechanical Reliability-1985	56.00	66.00*
		Products for Personal Computers		
( )	RAC-NRPS	Nonoperating Reliability Prediction Software (Price includes NONOP-1 listed above)	1400.00	1450.00**
( )	FNPRD-3	Floppy Disk Copy (IBM Compatible)	125.00	135.00*
( )	FMDR-21A	Floppy Disk Copy (IBM Compatible)	175.00	185.00*
		State-of-the-Art Reports		
( )	SOAR-2	Practical Statistical Analysis for the Reliability Engineer	36.00	46.00*
( )	SOAR-3	IC Quality Grades: Impact on System Reliability and Life Cycle Costs	46.00	56.00*
( )	SOAR-4	Confidence Bounds for System Reliability	46.00	56.00*
( )	SOAR-5	Surface Mount Technology: A Reliability Review	56.00	66.00*
( )	SOAR-6	ESD Control in the Manufacturing Environment	56.00	66.00*
		Technical Reliability Studies		
( )	TRS-1	Microcircuit Screening Effectiveness	36.00	46.00*
( )	TRS-2	Search and Retrieval Index to IRPS Proceedings-1968 to 1978	24.00	34.00**
( )	TRS-2A	Search and Retrieval Index to IRPS Proceedings-1979 to 1984	24.00	34.00*
( )	TRS-3A	EOS/ESD Technology Abstracts-1982	36.00	46.00*
( )	TRS-4	Search and Retrieval Index to EOS/ESD Proceedings-1979 to 1984	36.00	46.00*
( )	TRS-5	Search and Retrieval Index to ISTFA Proceedings 1978-1985	36.00	46.00*
		Electrical Overstress/Electrostatic Discharge Symposium Proceedings		
( )	EOS-1	1979 Proceedings	24.00	34.00*
( )	EOS-2	1980 Proceedings	24.00	34.00*
( )	EOS-3	1981 Proceedings	24.00	34.00*
( )	EOS-4	1982 Proceedings	24.00	34.00*
( )	EOS-5	1983 Proceedings	24.00	34.00*
		Complete Set of Past Proceedings: $105 ($145 non-U.S.)***		
( )	EOS-6	1984 Proceedings	24.00	34.00*
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*****For air mail shipment to points outside North and Central America, add $35.00 per item**
******VIDEO TAPES** not included in quantity purchase discount.

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Quantity	Discount	Quantity	Discount
1-2	list	10-19	30% off list
3-6	15% off list	20-49	40% off list
7-9	20% off list	50-99	50% off list
		100 or more	negotiable

ORDERING SECTION

Check

( ) Please find enclosed $_____, for the documents in the quantities indicated.
( ) Please find enclosed $_____, (min. $500 U.S., $575 non-U.S.) for the RAC Full Service Plan.
( ) Please find enclosed $_____, ($125 U.S., $215 non-U.S.) for one year MRAP/SRAP.

Please send above information to:

Name/Title_____
Company/Organization_____
Address_____
City/State_____
Phone_____

Mail this order to:

Reliability Analysis Center
RADC/RAC
Dept. Marketing
Griffiss AFB, NY 13441-5700
Phone: (315) 330-4151
Autovon: 587-4151

Prepayment of orders is required. Please make checks payable to IITRI/RAC. Foreign orders must be accompanied by check drawn on a U.S. bank.

The Reliability Analysis Center is a DoD Information Analysis Center operated by IIT Research Institute, Chicago, IL

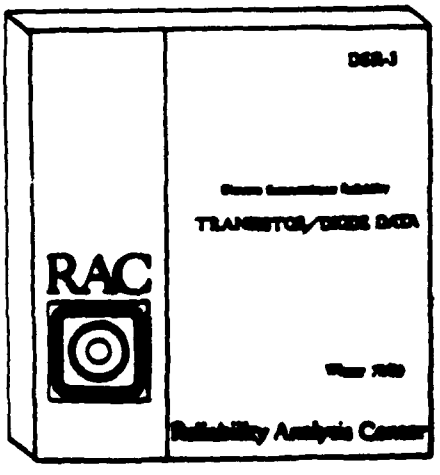
RAC INFORMATION PACKAGE

Reliability Analysis Center

RADC (RAC) GRIFFISS AFB NY 13441-5700
(315) 330-4151 AUTOVON 587-4151

TRANSISTOR/DIODE DATA (DSR-3)

This compilation of reliability data on discrete semiconductors contains information valuable in device selection, failure rate prediction, test specification, screening and corrective action decisions. Detailed and summarized failure rate data derived from field observations and environmental testing describe a wide range of devices used in a variety of electronic systems. 1979, 1980, 420 pages.



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FUTURE PUBLICATIONS

This list is meant to provide the user community with insight into the latest RAC efforts. The dates shown are "ball park" estimates and subject to change without notice. Please call or write for the current status of a specific publication.

MDR-22	Microcircuit Device Screening Analysis	Spring '87
NONOP-1	Nonoperating Reliability Data	Winter '86
SOAR-2A	Practical Statistical Analysis for the Reliability Engineer (updated)	Spring '87
EEMD-2	Electronic Equipment Maintainability Data	Spring '87
DSR-4	Discrete Semiconductor Reliability	Spring '87
MDR-23	Microcircuit Device Life Data and Analysis	Summer '87
VZAP-2	ESD Susceptibility of Electronic Devices	Summer '87
SOAR-7	Environmental Stress Screening (ESS) Effectiveness	Summer '87

To support these publications and future studies the RAC is continually striving to acquire the most current and useful data. Anyone wishing to participate in the RAC's ongoing data collection efforts (proprietary data will be kept confidence). Please contact James P. Carey at the above address.

RAC RELIABILITY ANALYSIS CENTER

Reliability Analysis Center/IIT Research Institute, P.O. Box 4700, Rome, NY 13440-8200 (315) 330-4151

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TOTAL OF ORDER .....

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Phone: _____ Ext: _____

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Street Address: _____

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State: _____ Zip: _____

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QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL COST

SPECIAL HANDLING - ADD $15.00 PER BOOK FOR AIRMAIL .....
QUANTITY DISCOUNT - SEE INSTRUCTIONS ON BACK .....
TOTAL OF ORDER .....

MAKE CHECKS PAYABLE TO IITRI/RAC

ORDERING INFORMATION

Place orders or obtain additional information directly from the Reliability Analysis Center. Clearly specify the publications and services desired. Except for blanket purchase orders, prepayment is required. All foreign orders must be accompanied by a check drawn on a U.S. bank. **Please make checks payable to IITRI/RAC.**

METHODS OF PAYMENT

Military Agencies. Blanket Purchase Agreement, DD Form 1155, may be used for ordering RAC reports and/or services. Please stipulate maximum dollar amount authorized and cutoff date on your order. Also specify services (i.e., publications, search services, etc.) to be provided. **Identify vendor as IIT Research Institute/Reliability Analysis Center.**

Full Service Participating Plan

Services provided to a participating member are:

- Automatic receipt of one (1) copy of each RAC publication issued during the participation period
- Availability of additional copies of each of the above publications at 20% off list price
- Discount on registration fees for RAC-sponsored training courses, seminars, workshops, etc.

The Plan may be opened in two ways:

- Pre-deposit of a minimum amount of $500 U.S., $575 non-U.S., the maximum to be determined by the requestor
- A purchase order for not less than the above amounts with a "not-to-exceed" amount indicated. IITRI/RAC will bill for services and publications on a quarterly basis.

In addition, the participating member may access RAC resources as needed without issuing purchase orders. RAC will maintain the account record of funds expended and furnish an account statement every 3 months or at the customer's request.

Quantity Purchase Discounts - Discounts on multiple copies ordered at one time and shipped to a single address are:

Quantity	Discount	Quantity	Discount
1-4	list	10-19	20% off list
5-9	10% off list	20 or more	negotiable

ORDERING INFORMATION

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Quantity	Discount	Quantity	Discount
1-4	list	10-19	20% off list
5-9	10% off list	20 or more	negotiable

ATTACHMENT II:

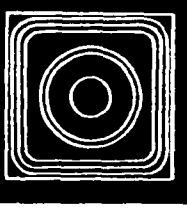
RAC TRAINING COURSE BROCHURES

design reliability

design reliability training course

An Intensive 4-Day Course on the Application of Reliability Tools for Designers

San Diego, CA
March 14–17, 1988
and
Virginia Beach, VA
June 6–9, 1988



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RAC DESIGN RELIABILITY TRAINING COURSE PARTICULARS

Course Dates	March 14-17 1988	June 6-9, 1988
Registration Deadline	March 4, 1988	May 27, 1988
Course Site and Hotel	Town & Country, Hotel 500 Hotel Circle North San Diego, CA 92138	Virginia Beach Plaza Hotel 4453 Bonney Road Virginia Beach, VA 23462
Hotel Telephone	(619) 291-7131	(804) 473-1700
Room Rates: Single Double Government	$55.00 $65.00 —	$50.00 $60.00 $49.00 *w/proper I.D*
Reservation Deadline*	February 22, 1988	May 23, 1988
Access to Hotel	15 minutes by car from San Diego Airport	10 minutes by car from Norfolk International Airport

*Each hotel is holding a block of guest rooms for course attendees. Room reservations must be made directly with the respective hotel prior to the deadline date. Be sure to identify yourself with the RAC Statistical Process Control Course in order to receive the special guest room rates.

RAC design reliability training course registration form

☐ SAN DIEGO, CA • MARCH 14–17, 1988 ☐ VIRGINIA BEACH, VA • JUNE 6–9, 1988

Name: _____ Title _____

Organization: _____ Division _____

Organization Address: _____
Street City State Zip

Telephone: Business _____ Home _____

Enclosed is a check for $ _____ to cover _____ registration(s) at $850 ($825 for Annual Participants*) each person.

If registering for more than one person, please list additional names and positions on an attached sheet.

*I am a Participant in the RAC Annual Service Plan. My Account No. is: _____

Make check payable (or address P.O.) to *IIT Research Institute*.
Mail to Reliability Analysis Center, P.O. Box 4700, Rome, NY 13440-8200
*Payment must be made by a check drawn on a U.S. Bank.
The Reliability Analysis Center is a DoD Information Analysis Center, operated by IIT Research Institute, Rome, NY.

design reliability

OVERVIEW

Featuring an exposition of guidelines for the achievement of reliability in equipment design, this design training course is specifically tailored for the instruction of electrical circuit design engineers (and managers) who have had little or no previous reliability training. It introduces the basic concepts and theory of reliability engineering along with rudimentary mathematical relationships and emphasizes the practical application of reliability tools which can be used by the designer. The course is designed to allow a maximum of individual participation and to foster the application of the demonstrated principles to specific reliability problems experienced by designers.

THE ORGANIZATION

The Reliability Analysis Center (RAC) is a DoD-sponsored Information Analysis Center located at Rome Air Development Center, Griffiss Air Force Base, New York, and is operated for the DoD by IIT Research Institute, Rome, New York. It is chartered to serve the needs of DoD and industry alike in all matters relating to electronic parts and equipment reliability.

COURSE OUTLINE

Introduction to Reliability Methodology (Mon. a.m.)

- A Scope and Course Content
- B General Concepts and Mathematics
  - 1 Definitions
  - 2 Equipment Life Charactenstics—Exponential Failure Rate
  - 3 Degradation Factors
  - 4 R&M Specifications
- C System Reliability Analysis
  - 1 Apportionment
  - 2 Modeling
  - 3 Prediction

Part Selection and Control (Mon. p.m.)

- A Specification and Control
  - 1 Part Quality Grades
  - 2 Procurement Methods
- B Integrated Circuit Screening
  - 1 Arrhenius Reaction Rate Model
  - 2 Technology Differences
  - 3 Die Related Failure Mechanisms
  - 4 Package Related Failure Mechanisms
  - 5 Screening Effectiveness
  - 6 VLSI Scaling Considerations

Reliability Evaluation Tools (Tues. a.m.)

- A Failure Mode Effects and Criticality Analysis
  - 1 Methodology and Examples
- B Reliability Demonstration Testing
  - 1 MIL-STD-781D + MIL-HDBK-781

Part Derating and Redundancy (Tues. p.m.)

- A Part Derating
  - 1 Part Derating Techniques
    - Temperature Stress Factors
  - 2 Specific Derating Factors
    - Microelectronics
    - Semiconductors
    - Resistors
    - Capacitors
    - Coils, Transformers
    - Relays
  - 3 Impact of Derating on Device Failure Rates
    - MIL-HDBK-217E Models
- B Redundancy
  - 1 General Concepts
    - Active
    - Standby
  - 2. Specific Examples

Circuit Analysis and ESD (Wed. a.m.)

- A Circuit Analysis
  - 1 System and Circuit Simplification
  - 2 Circuit Degradation Analysis
  - 3 Overstress and Transient Analysis
- B Electrostatic Discharge Considerations
  - 1 Nature of Static Electricity
  - 2 Device and Equipment Susceptibility to ESD Damage
  - 3 Input Protective Networks
  - 4 Precautionary Measures
  - 5 Case Histories

***Fault Tree and Reliability Growth* (Wed. p.m.)**

- A Fault Tree Analysis
  - 1 Methodology and Examples
- B Reliability Growth Management
  - 1 The Growth Process
  - 2 Growth Test Planning
  - 3 Duane Plots
  - 4 Stimulating Latent Defects
  - 5 Failure Reporting and Corrective Action Systems

Production and Use Reliability and Environment (Thurs. a.m.)

- A Production and Use Reliability
  - 1 Degradation Contributions
    - Production Factors
    - Inspection Factors
    - Field Factors
  - 2 Maintenance and Maintainability
    - General Concepts
    - Hardware Partitioning
    - Ease of Maintenance Guidelines
    - Fault Diagnosis and Compatibility
- B Designing for the Environment
  - 1 Design Techniques to Mitigate These Effects
    - Thermal
    - Shock
    - Vibration
    - Humidity
    - Salt Atmosphere
    - EMI Radiation
    - Nuclear Radiation

Design to Cost and Reliability Management (Thurs. p.m.)

- A. Design to Cost
  - 1. Overview
    - Philosophy
    - DoD Resource Allocation
    - Cost Elements
  - 2. Defining Cost and Reliability Targets
    - Concept-Level Trade Off Analyses
    - Detailed Cost Reliability Analyses
    - Cost Modeling
    - Component Cost vs Cost of Failures
- B Management Considerations
  - 1 Reliability Control Program Elements
  - 2 Program Planning
- C Reliability Data Sources
  - 1 Reliability Analysis Center
  - 2 GIDEP
  - 3 Other Data Sources

Final Group Problem

Registration: Complete the Registration Form in this flyer and mail with your check or purchase order to the Reliability Analysis Center. We urge you to register as soon as possible, as acceptance of applications cannot be guaranteed after the deadline dates indicated for each course. Substitution of attendees may be made on a day-to-day basis without penalty.

Fee: $850 ($825 for Participants in RAC Annual Services Plans). This fee includes attendance at the 4-day session, hand-out materials, including one copy of the Reliability Design Handbook per attendee, lunches and coffee breaks. Hotels are not included.

Multiple-Attendance Discounts: The discount schedule for course attendance by several persons from one corporate entity is:

No. of Attendees	% Discount
1-2	None
3-5	10%
6-9	20%
10-19	30%
20 or more	negotiable

Refunds: Registration refunds will be made to any paid registrant who informs RAC of his/her intent to cancel by a letter postmarked no later than one week before the course begins.

Instruction Periods: Classes run from 8:30 a.m. to 4:30 p.m. daily.

LODGING

Each hotel has reserved a block of guest rooms for course attendees. Room reservations must be made directly with the respective hotel prior to the deadline date indicated. Be sure to identify yourself with the RAC Design Reliability Training Course in order to receive the special guest room rates.

ADDITIONAL INFORMATION

For further information on this course contact Ms. Nan Pfrimmer at the Reliability Analysis Center (315) 330-4151.

COURSE INSTRUCTORS

Mr. Norman B. Fuqua has 25 years' experience in reliability covering various civilian, military and space programs. As a research engineer at IIT Research Institute assigned to the Reliability Analysis Center since 1972, he has been responsible for planning, directing and implementing a number of reliability and maintainability study programs. His current areas of concentration are reliability education and the prevention of damage to electronic equipments caused by electrostatic discharge. He has been the principal architect of the Design Reliability Training Course and has acted as principal instructor in every one of the scores of course presentations made to several thousand students since 1977.

As a reliability engineer with the Delco Electronics Div. of GMC he served as a member of the flight readiness review team for some of the Apollo and Lunar Excursion missions. His BSEE is from the University of Illinois. He is a senior member of the IEEE and a Registered Professional Engineer in California.

Mr. Stanislaw Kus has been active in the field of reliability, maintainability and associated disciplines since 1951. He has planned and directed numerous study efforts and programs as they apply to both military systems and industrial equipments. As a consultant to the Air Force he was responsible for planning and evaluating the reliability, maintainability and producibility program for a large multi-mode (electronically agile) airborne radar system. He has performed studies to evaluate the reliability of medical instrumentation including pacemakers, respirators and other cardiovascular devices.

Prior to joining IITRI Mr. Kus managed a reliability engineering group for a large industrial organization. He was responsible for planning and implementing R&M development programs and was also responsible for component engineering efforts applicable to microcircuits, semiconductors and other component parts. He performed failure analyses of electronic and electromechanical parts including solid-state components and established cost-effective reliability burn-in/screening programs. He studied at the Hungarian Institute of Technology and has a BSEE from the Illinois Institute of Technology.

COURSE OVERVIEW

This intensive, fast-paced course is structured specifically to help the non-statistician who needs to apply statistical methods or understand their use in technical reports. We stress that a basic understanding of probability and of basic statistics is an advantage. It introduces the non-specialist to statistical concepts with a minimum of mathematics and explains (by example) some popular methods applicable to practical reliability studies. It also provides a basic understanding of the statistics commonly used in technical reports and supplies the background and references to more advanced methods, while indicating their potential.

The course has been developed at RAC utilizing actual reliability studies on failure data analysis.

Engineering mathematics to degree level is a preferred student competence to facilitate full understanding of course content.

Students should expect to spend an average of 2 hours each evening on problems/exercises.

GENERAL INFORMATION

Registration: Complete the *Registration Form* and mail with your check or purchase order to the RAC. We urge you to register as soon as possible in order to meet the deadline dates indicated for each course. Substitution of attendees may be made on a day-to-day basis without penalty.

Fee: $850 ($825 for Participants in RAC Service Plan). This fee includes attendance at the 4-day session, hand-out materials, including one copy of the RAC publication SOAR-2 per attendee, lunches and coffee breaks. Hotels are not included.

Multiple-Attendance Discounts: The discount schedule for course attendance by several persons from one corporate entity is:

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6-9	20%
10-19	30%
20 or more	negotiable

Refunds: Registration refunds will be made to any paid registrant who informs RAC of his/her intent to cancel by a letter postmarked no later than one week before the course begins. Cancellation without notice to RAC or after the deadline will result in a service charge of $100.00 per person.

Instruction Periods: Classes run from 8:00 AM to 5:00 PM daily.

LODGING: Each hotel has reserved a block of guest rooms for course attendees. Room reservations must be made directly with the respective hotel prior to the deadline date indicated. Be sure to identify yourself with the **RAC Practical Statistical Analysis Training Course** in order to receive the special guest room rates.

ADDITIONAL INFORMATION. Contact Nan Pfrimmer at the Reliability Analysis Center, (315) 330-4151.

RAC PRACTICAL STATISTICAL ANALYSIS TRAINING COURSE PARTICULARS

COURSE DATES	August 11—14, 1986	December 8—11, 1986
REGISTRATION DEADLINE	August 1, 1986	November 17, 1986
COURSE SITE AND HOTEL	CLARION HOTEL/DENVER AIRPORT 3202 Quebec Street Denver, CO 80207	SHERATON-TWIN TOWERS 5780 Major Boulevard Orlando, FL 32805
HOTEL TELEPHONE	(303) 321-3333	(305) 351-1000
ROOM RATES—Single	$69.00	$60.00
—Double	$69.00	$70.00
RESERVATION DEADLINE*	July 10, 1986	November 21, 1986
ACCESS TO HOTEL	Five minutes by car from Stapleton Airport. Complimentary airport shuttle available	Fifteen minutes by car from Orlando Int'l Airport

*Each hotel is holding a block of guest rooms for course attendees. Room reservations must be made directly with the respective hotel prior to the deadline date. Be sure to identify yourself with the **RAC Practical Statistical Analysis Training Course** in order to receive special guest room rates.

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PRACTICAL STATISTICAL ANALYSIS WITH RELIABILITY APPLICATIONS

AN INTENSIVE FOUR-DAY COURSE
FOR THE
NON-STATISTICIAN

Denver, CO **August 11 — 14, 1986**

Course also offered at ...

Orlando, FL **December 8 — 11, 1986**

RAC
Reliability Analysis Center
RADC/RAC, Griffiss AFB, NY 13441-5700
(315) 330-4151 AUTOVON 587-4151

PRACTICAL STATISTICAL ANALYSIS TRAINING COURSE

The Sponsoring Organization

The Reliability Analysis Center (RAC) is a Department of Defense sponsored Information Analysis Center specializing in the reliability of electronic equipment. It is located at Rome Air Development Center, Griffiss Air Force Base, New York and is operated for the DoD by IIT Research Institute, Rome, New York. It is chartered to serve the needs of the DoD and industry alike in all matters relating to electronic parts and equipment reliability.

COURSE INSTRUCTORS

Kieron A. Dey: Mr. Dey has been involved with diverse areas of industry particularly in the applied statistics and operations research fields. He has provided statistical support to the engineering staff at the Reliability Analysis Center, managed the Reliability Programs Group at IIT Research Institute and currently is Technical Director for the RAC.

Mr. Dey holds a BS in mathematics/statistics from University of Reading, England and an MBA from Rensselaer Polytechnic Institute. He is a fellow of the Royal Statistical Society and a member of the American Statistical Association. He is the author of several papers and of the publication "Practical Statistical Analysis for the Reliability Engineer" (SOAR 2) which serves as the text for this course. This document is issued by the RAC in its chartered function as an Information Analysis Center.

Mary A. Hartz: Dr. Hartz is the statistical advisor to the RAC and to IITRI's Reliability Technology Division. In addition, she conducts statistical projects and training courses for industry. Currently she is the principal investigator on an IITRI-sponsored research program in statistical quality and process control.

Dr. Hartz earned her BS in mathematics and mathematics education and her MA and PhD in Applied Statistics from Syracuse University. She has been a member of several professional societies and has authored numerous publications and papers. Formerly, she was a Senior Statistician at the BF Goodrich Research and Development Center where she focused on the design and analysis of experimental studies in many application areas. Previously, she had been a faculty member at the University of Pittsburgh. She is an ASQC Certified Quality Engineer.

Jorge L. Romeu: Mr. Romeu has fourteen years of experience as a statistician and applied mathematician in the fields of petroleum, construction, agriculture and hardware and software engineering. Currently his work involves development of system reliability confidence bounds, interactive statistical tools and software data analysis. He has published several statistical papers addressing both hardware and software problems. He has also taught statistics at Syracuse University.

Mr. Romeu holds an MS in Mathematical Statistics from the University of Havana and an MS in Operations Research from Syracuse University where he is currently working on his PhD thesis in applied statistics. He is a fellow of the Institute of Statistics and a member of the American Statistical Association.

COURSE OUTLINE

First Day

Review – Probability theory and basic statistical concepts. (This session is designed to bring everyone to the same level and will be structured to fit in with individual class qualifications.)

The Concept of Hypothesis Testing – Outlines the meaning of significant differences and how to set up tests to evaluate such differences. Discussion of concepts such as confidence, risk, significance and hypothesis testing.

Confidence Intervals – Mathematical, practical and allegorical definitions, relation to significance tests.

Theoretical Distributions – The use of some distributions (binomial, normal, Student's t, Chi-square and F) for statistical inference on population parameters. (Depending upon class background, this may be a review session.) Computer examples.

Use of Statistical Tables – Presents the proper use of statistical tables; students will gain practical experience in using the tables throughout the course.

The Case for Non-Parametrics – Introduces the nonparametric approach to statistics and contrasts parametrics and nonparametrics in practical application settings.

Analysis of Variance – Gives an overview of one of the more complex statistical methods often used to separate the various factors influencing a set of data (e.g., simultaneous effects of environment and time on reliability). Examples are from both reliability and electrostatic discharge data and use the classic method as well as the nonparametric approach of Kruskal and Wallis. Computer problem solving.

Second Day

The Correlation Coefficient – How to measure the extent to which two variables vary together using both the parametric (Pearson) and nonparametric (Spearman) approaches. The difference between correlation and causation. Examples from large plant machinery.

Regression Analysis – The least squares method of curve fitting, the linear model and alternatives are discussed. "How good is the fit?" and "How good is good?" are answered. Methods for searching out a better fit are suggested. The differences between scientific, predictive and control models are introduced. The method is extended to covariance analysis using automobile reliability data. Graphical method for quick least squares fitting. Problem solving using the computer.

Third Day

Reliability Distributions – Introduction to Poisson, exponential, Weibull and log normal distributions. The corresponding probability density, cumulative density, hazard, and reliability functions for each will be presented along with a discussion of the Bathtub curve and the appropriateness of alternative distributions for semiconductors.

Reliability Inferences – Hypothesis testing and confidence intervals related to reliability. Extension to nonparametrics.

Weibull Plotting and Analysis – Practical instruction on analysis of life and other data using probability paper, interpretation of results. Computer plotting.

Goodness of Fit Tests – To determine how well a given set of data fits a theoretical distribution. Examples are provided using the Chi-square, Kolmogorov-Smirnov methods. Advantages of the use of each method are clearly demonstrated. Computer examples.

Fourth Day

Life Testing – Practical and theoretical issues.

Reliability Demonstration – Basic concepts (α, β, discrimination ratio, O-C curves). Use of MIL-STD-781.

Fixed Length and Sequential Testing – Decision criteria for practical testing plans.

Sampling Inspection – Review of sampling, producer and consumer risks, sample size, LTPD and AQL, O-C curves. Double and single sampling. Applications using MIL-STD-883 and MIL-M-38510.

Reliability Growth – The statistical model for tracking reliability improvement in time (AMSAA model). The empirical model for tracking reliability improvement in time (Duane model).

Who Should Attend?

- Quality/Reliability Managers
- Project Managers
- Quality/Reliability Engineers
- Hardware Designers
- Reliability Technicians with required mathematical/statistical pre-requisites

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REGISTRATION FORM — PRACTICAL STATISTICAL ANALYSIS TRAINING COURSE

☐ **Denver, CO • August 11—14, 1986** ☐ **Orlando, FL • December 8—11, 1986**

Name ______________________ Title ______________________

Organization ______________________

Organization Address ______________________

Telephone Business ______________________ Home ______________________

Enclosed is a check for $ ________ to cover ________ registrations at $850 ($825 for Annual Participants*) each person

If registering for more than one person please list additional names and positions on an attached sheet

*I am a Participant in the RAC Service Plan. My Account No is ________

Make check payable (or address P.O.) to **IIT Research Institute**. Mail to Reliability Analysis Center, RADC/RAC, Griffiss AFB NY 13441-5700

*Payment must be made by a check drawn on a U.S. Bank

The Reliability Analysis Center is a DoD Information Analysis Center operated by IIT Research Institute, Rome, NY

Reliability Analysis Center
P O. Box 4700
Rome, NY 13440-8200

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RAC TESTABILITY PRACTICES TODAY PARTICULARS

Course Dates	March 29-31, 1988	July 12-14, 1988
Registration Deadline	March 22, 1988	July 1, 1988
Course Site and Hotel	Holiday Inn 6515 International Drive Orlando, FL 32819	Virginia Beach Plaza Hotel 4453 Bonney Road Virginia Beach, VA 23462
Hotel Telephone	305-351-3500	804-473-1700
Room Rates: Single Double Government	$58.00 $65.00 $48.00 w/proper I.D.	$50.00 $60.00 $49.00 w/proper I.D.
Reservation Deadline*	March 14, 1988	June 20, 1988
Access to Hotel	15 minutes by car from Orlando International Airport	10 minutes by car from Norfolk International Airport

*Each hotel is holding a block of guest rooms for course attendees. Room reservations must be made directly with the respective hotel prior to the deadline date. Be sure to identify yourself with the RAC Testability Practices Course in order to receive the special guest room rates.

COURSE INSTRUCTOR

John L. Tunno, president of Logical Solutions Technology, Inc., has twenty years' experience in all aspects of testing. His technical background extends from electrical parametric testing of processed silicon wafers through field service testing of complex electronic systems and from system and circuit design through programming and applications support.

Educated in management and electronics engineering at El Camino College and West Coast University, Mr. Tunno is the author of three books and numerous articles and papers. He has lectured on testing and test equipment throughout the United States and Europe. He is a frequent participant at conferences including ATE Seminars, NEPCON, ASEE and European ATE conferences. Mr. Tunno is a member of IEEE, the Professional and Technical Consultants Association, co-chairman of the IEEE Testability Bus Standards Committee, president of the American Society of Test Engineers, Fellow in the Institute for Quality Assurance (U.K.) and a Fellow in the Society of Test Engineering.

ON-SITE RAC TUTORIALS

Acting under a DoD directive which requires that RAC operate on a cost-recovery basis, RAC prepares and sells microelectronic reliability and maintainability databooks and state-of-the-art reports, and offers consulting services and tutorials.

Tutorials which can be presented privately to a select audience at a site provided by the customer in the U.S. or overseas, are:

- Design Reliability Training Course
- Practical Statistical Analysis with Reliability Applications
- Practical Mechanical Reliability
- Electronic Equipment Testability
- Statistical Process Control
- Testability Practices Today

Information on how to arrange for private on-site tutorials is available upon request. Address your request to J.W. Wilbur, Mgr Training Operations, at the masthead address or call him at (315) 330-4151.

TESTABILITY PRACTICES TODAY

THE ORGANIZATION

The Reliability Analysis Center (RAC) is a DoD sponsored Information Analysis Center located at Rome Air Development Center (Griffiss AFB) in Rome, New York, and is operated for the DoD by IIT Research Institute, Rome, New York. It is chartered to serve the needs of DoD and industry activities relating to electronic parts and equipment reliability.

COURSE OUTLINE

Day 1

Setup and Participant Registration — 8:30 - 9:00 a.m.

Seminar Workshop Outline, Introductory Remarks — 9:00 - 10:30 a.m.

Data Exchange

- Introduction of Personnel
- Current Test Practices
- Planned Test Practices
- Types of Testing Problems
- Cost and Schedule Data
- Organizational Considerations
- Testability Program Flow
- Introduction of Key Testability Standards
  - MIL-STD-2165
  - DEF STAN 00-13/2
  - Proposed IEEE Testability Bus Standard

COFFEE BREAK — 10:30 - 10:45 a.m.

Definitions, Goals and Economics — 10:45 - 12:00 a.m.

- Testability Definitions
- Testability Goals
- Testability Economics
- Testability Benefits
- Built-in Test Impact on Life Cycle Costs

LUNCH — 12:00 - 1:00 p.m.

ATE Test Techniques & Strategies — 1:00 - 2:30 p.m.

- Component Test Techniques
- Board Test Techniques
- System Test Techniques
- Preferred Manufacturing Test Flow

COFFEE BREAK — 2:30 - 2:45 p.m.

Test Strategy Workshop — 2:45 - 4:30 p.m.

- Participants will chart the flow of three possible test alternatives, calculate the economic impact of each, and select the best strategy.

Day 2

System Guidelines — 9:00 - 10:30 a.m.

- Removeable BITE Concept
- Test Points, Test Connectors
- Visual Indicators
- Ground Points
- Feedback Loops
- Partitioning

Testability Guidelines — Digital

- Initialization
- Monostable Multivibrators
- Built-in Test Equipment
- Feedback Loops
- Oscillators and Clocks
- Bussed Logic
- Buffers
- Visibility
- Partitioning
- Wired OR/AND Functions
- Counters, Shift Registers

COFFEE BREAK — 10:30 - 10:45 a.m.

SSI/MSI Digital Guidelines Workshop 10:45 - 12:00 a.m.

- Participants will review a sample SSI/MSI schematic and make appropriate recommendations and calculate economic impact of their recommendations.

LUNCH — 12:00 - 1:00 p.m.

LSI/VLSI Guidelines — 1:00 - 2:30 p.m.

- Problems of LSI/VLSI
- Advantages of LSI/VLSI
- General LSI/VLSI Guidelines
- Structured LSI/VLSI Guidelines (8085, 8048, 8086, 68000, others as requested)

COFFEE BREAK — 2:30 - 2:45 p.m.

Surface Mount Technology (SMT) Guidelines — 2:45 - 4:30 p.m.

LSI/SMT Workshop

- Participants will review a surface mount assembly with LSI devices and make appropriate testability recommendations and calculate their economic impact.

Day 3

Selected Mechanical Guidelines — 9:00 - 10:30 a.m.

- Accessibility
- Connectors
- Board Layout
- Adjustments
- Subassemblies on Sides
- Extender Boards

Analog Guidelines

- Adjustments
- Signal Interfaces — I
- Metering
- Impedance Matching
- Partitioning
- Visibility
- Signal Interfaces — II
- Buffering Critical Signals
- Combining Analog Test Points
- AGC and AFC Feedback Loops
- Other Analog Guidelines

Software Guidelines

- Testability Documentation

COFFEE BREAK — 10:30 - 10:45 a.m.

Proposed IEEE Standard Testability Bus Definition — 10:45 - 12:00 a.m.

- Testability Chip Set
- Testability Bus Applications

LUNCH — 12:00 - 1:00 p.m.

Military Standards — 1:00 - 2:30 p.m.

- Testability Program for Electronic Equipment and Systems (2165)
- English Ministry of Defense Standard 00-13/2

Testability Rating Systems

- 2165 Appendix B Rating System
- T Score Rating System
- Logical Solutions Checklists

Rating System Workshop

- Participants will apply both the rating systems presented to a sample design and calculate the figure of merit and compare the methods.

COFFEE BREAK — 2:30 - 2:45 p.m.

Wrap-Up and Conclusions — 2:45 - 4:30 p.m.

- Highlights from Workshops
- Testability Trends in the Future

ADJOURN — 4:30 p.m.

ENROLLMENT INFORMATION

Registration Complete the Registration Form on this flyer and mail with your check or Purchase Order to the Reliability Analysis Center. We suggest you register as soon as possible as all seating for applications cannot be guaranteed after the deadline dates indicated for each course. Substitutions of attendees may be made on a day-to-day basis without penalty.

Fee $700 ($675 for Participants in RAC Annual Services Plan). This fee includes attendance at the 3-day session, handout materials, lunches and coffee breaks. Hotels are not included.

Multiple-Attendance Discounts The discount schedule for course attendance by several persons from one corporate entity is:

No. of Attendees	% Discount
1 - 2	None
3 - 5	10%
6 - 9	20%
10 - 19	30%
20 or more	negotiable

Refunds Registration refunds will be made to any paid registrant who informs RAC of his decision to cancel by a letter postmarked no later than one week before the course begins.

Instruction Periods Classes run from 8:30 a.m. to 4:30 p.m. daily.

LODGING

Each hotel has reserved a block of guest rooms for course attendees. Room reservations must be made directly with the respective hotel prior to the deadline date indicated. Be sure to identify yourself with the RAC Testability Practices Today Training Course in order to receive the special guest room rates.

ADDITIONAL INFORMATION

For further information on this course contact Ms. Nan Pfrimmer at the Reliability Analysis Center, (315) 330-4151.

RAC Testability Practices Today Tutorial Registration Form

ORLANDO, FL · MARCH 29-31, 1988 — **VIRGINIA BEACH, VA · JULY 12-14, 1988**

Name _____ Title _____

Organization _____ Division _____

Organization Address _____
Street City State Zip

Telephone: Business _____ Home _____

Enclosed is a check for $ _____ to cover _____ registration(s) at $700 ($675 for annual Participants*) each person.

If registering for more than one person, please list additional names and positions on an attached sheet.

*I am a Participant in the RAC Annual Service Plan. My Account No. is _____

Make check payable (or address P.O.) to: *IIT Research Institute.*
Mail to: Reliability Analysis Center, P.O. Box 4700, Rome, NY 13440-8200
*Payment must be made by a check drawn on a U.S. Bank.
The Reliability Analysis Center is a DoD Information Analysis Center, operated by IIT Research Institute, Rome, NY.

ENROLLMENT INFORMATION

Registration: Complete the Registration Form in this flyer and mail with your check or purchase order to the Reliability Analysis Center. We urge you to register as soon as possible, as acceptance of applications cannot be guaranteed after the deadline dates indicated for each course. Substitution of attendees may be made on a day-to-day basis without penalty.

Fee: $850 ($825 for Participants in RAC Annual Services Plans). This fee includes attendance at the 4-day session, hand-out materials, including one copy of the course manual per attendee, lunches and coffee breaks. Hotels are not included.

Multiple-Attendance Discounts: The discount schedule for course attendance by several persons from one corporate entity is:

No. of Attendees	% Discount
1-2	None
3-5	10%
6-9	20%
10-19	30%
20 or more	negotiable

Refunds: Any paid registrant who wishes to cancel a registration will have the registration fee returned by RAC provided RAC is informed of his/her intent to cancel by a letter postmarked no later than one week before the start of the course.

Instruction Periods: Classes run from 8:30 a.m. to 4:30 p.m. daily.

LODGING

Each hotel has reserved a block of guest rooms for course attendees. Room reservations must be made directly with the respective hotel prior to the deadline date indicated. Be sure to identify yourself with the RAC Worst Case Analysis Training Course in order to receive the special guest room rates.

ADDITIONAL INFORMATION

For further information on this course contact Ms. Nan Pfrimmer at the Reliability Analysis Center (315) 330-4151

RAC Worst Case Analysis Training Course Particulars

COURSE DATES	May 11-14, 1987	August 17-20, 1987
REGISTRATION DEADLINE	May 1, 1987	August 7, 1987
COURSE SITE AND HOTEL	Town & Country Hotel 500 Hotel Circle North San Diego, CA 92138	Sheraton Inn Syracuse 7th North Street & Electronics Parkway Syracuse, NY 13088
HOTEL TELEPHONE	(619) 291-7131	(315) 457-1122
ROOM RATES—Single —Double	$55.00 $65.00	$48.00 $48.00
RESERVATION DEADLINE*	April 19, 1987	June 17, 1987
ACCESS TO HOTEL	15 minutes by car from San Diego Airport	10 minutes by car from Syracuse Hancock Airport

*Each hotel is holding a block of guest rooms for course attendees. Room reservations must be made directly with the respective hotel prior to the deadline date. Be sure to identify yourself with the RAC Worst Case Analysis Training Course in order to receive the special guest room rates.

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RADC/RAC
Griffiss AFB, NY 13441-5700

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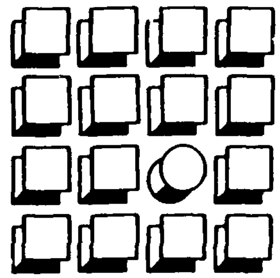

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Registration Form — RAC Worst Case Analysis Training Course

☐ **San Diego, CA • May 11-14, 1987** ☐ **Syracuse, NY • August 17-20, 1987**

Name ______________________ Title ______________________

Organization ____

Organization Address ________ Street ________ City ________ State ________ Zip

Telephone Business ______________ Home ______________

Enclosed is a check for $ ________ to cover ________ registration(s) at $850 ($825 for annual Participants*) each person

If registering for more than one person, please list additional names and positions on an attached sheet

*I am a Participant in the RAC Annual Service Plans My Account No is ______________

Make check payable (or address P O) to **IIT Research Institute.** • Mail to Reliability Analysis Center, RADC RAC, Griffiss AFB NY 13441 5700

The Reliability Analysis Center is a DoD Information Analysis Center operated by IIT Research Institute, Chicago, IL

THE SPONSORING ORGANIZATION

The Reliability Analysis Center (RAC) is a DoD sponsored Information Analysis Center located at Rome Air Development Center, Griffiss Air Force Base, New York and is operated for the DoD by IIT Research Institute Chicago, Illinois It is chartered to serve the needs of DoD and industry alike in all matters relating to electronic parts and equipment reliability

This tutorial was prepared under contract to RAC by the engineering consultant firm, Design and Evaluation, Inc , 1000 White Horse Rd , Voorhees, NJ 08043

COURSE INSTRUCTORS

• **James R McDonald** Mr McDonald has twenty four years of industrial experience, sixteen as a graduate engineer in electrical system design analysis and testing, principally with aerospace flight and ground support equipment He spent four years with the USAF in maintenance of Radar and Communications systems

He holds a BSEE in Electrical Engineering (1963) from Drexel University

• **Harry E Peacock** Mr Peacock has twenty six years of experience as an electrical/ electronic radar circuit and systems design engineer in the high technology field of missiles and aerospace reentry vehicles His broad experience in the reliability and maintainability (R&M) aspects of power systems includes worst case analysis (WCA) and the radiation tolerance of semiconductors, circuits and their enclosures

He holds a Master's Degree in Electrical Engineering from Drexel University

• **Michael S Raitman** Mr Raitman has eleven years of experience in the fields of digital electronics and software development, with a strong background in microprocessor and digital electronics design He has considerable expertise in microprocessor-based real-time software development on such processors as the Intel 8085, Motorola 6800 and 6809, and the IBM PC

He holds a BSEE from Drexel and an MSEE in Computer Engineering from Villanova

COURSE OUTLINE

First Day (a m)

A Introduction Scope and content of the course

B Overview of WCA
1 The circuit design problem
2 Concepts and impact of parts and environmental variables
3 Unique philosophies of WCA
4 W C environment and effects
5 Concepts of "sensitivity" and "functional margin"
6 Worst Case Analysis methodology

First Day (p m)

A Data Base generation for WCA
1 Definition of a data base and its importance
2 Random variations and "biases"
3 Temperature and radiation considerations
4 Temperature scaling procedures
5 Life prediction for part value change

B Comments on local thermal environmental effects
1 Thermal analysis methods
2 Approximate mathematical techniques
3 Nodal general purpose heat transfer programs (SINDA, TPO)

Second Day (a.m.)

A Parameter sensitivity — Magnitude and direction
1 Definition of sensitivity
2 Component parameter sensitivity determination mathematics
3 Monotonic and non-monotonic sensitivity

Second Day (p.m.)

A Numerics of variables for WCA
1 Three numerical approaches to WCA
a Extreme Value Analysis (EVA)
b Root-Sum-Squared (RSS)
c Monte Carlo (MC)
2 EVA as primary mode
3 RSS as alternative mode
4 MC as alternative mode
5 Comparison of three methods
a advantages/disadvantages
b when and why RSS and MC would be used

Third Day (a m)

A How to accomplish the WCA
1 General guidelines
2 Block diagramming and circuit partitioning
3 Circuit attribute and interface specifications
4 Determining attributes and planning the WCA
5 W C guidelines for Digital Circuits
a Timing analysis
b Temperature and capacitance effects on propagation delays
c CMOS considerations
6 Analogue parts attributes

B Parts Applications
1 Correct parts application
2 Sources of application data
3 Application review as a WCA task

C Worst Case Stress Analysis
1 Data collection/organization
2 An efficient approach to W C stress
a "Discovering" components exempt from analysis
b W C stress methodology by example
3 Often ignored stress factors

Third Day (p.m.)

A Circuit Models and equations
1 Circuit simulations
2 Approximation/simplification
3 A problem worked through — 10KHZ filter
4 Use of RSS as measure of failure criticality

Fourth Day (a.m.)

A Computer aided WCA
1 Advantages and limitations
2 Available computer programs
3 Active device and IC models
4 Doing EVA by computer
5 ECA 1 program as an example
a modeling, AC, DC analyses
6 A main frame program example — 10KHZ filter
7 Logic simulation programs

Fourth Day (p.m.)

A When models break down — what to do
B When a circuit "fails to meet" requirements by EVA
C Generation of a formal report
D W C management and control aspects
E Conclusions and considerations

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Rome Air Development Center

RADC plans and executes research, development, test and selected acquisition programs in support of Command, Control, Communications and Intelligence (C^3I) activities. Technical and engineering support within areas of competence is provided to ESD Program Offices (POs) and other ESD elements to perform effective acquisition of C^3I systems. The areas of technical competence include communications, command and control, battle management, information processing, surveillance sensors, intelligence data collection and handling, solid state sciences, electromagnetics, and propagation, and electronic, maintainability, and compatibility.